

SCIENCE ABSTRACTS

Section A.—PHYSICS.

MAY 1908.

GENERAL PHYSICS.

698. The Sprung Rain-gauge and a New Rain Autograph. W. Gallenkamp. (Zeitschr. Instrumentenk. 28. pp. 88-88, Feb., 1908.)—The author fears that Sprung's modification of the Gallenkamp rain autograph will not record every drop in a heavy shower. There may be four raindrops per sec., and the one drop may not have run down between the two contacts before a second drop follows [see Abstract No. 1 (1908)]. The continuous records would, moreover, be too small. The author now lets the drops fall on a steel reed which, under the weight of the drop, dips into a mercury cup; the marks thus recorded have to be counted, which is inconvenient, but the apparatus is not sensitive to dust, as Sprung's contact must be. A rain autograph might be constructed on the lines of Hellmann's float. The pipe connecting the gauge funnel with the receptacle is bent up again, and this vertical branch is slotted; over this portion fits the float-tube which carries the recording style. The rain, passing through the slot into the sleeve, forces the float up. The whole device is contained in a water chamber in which the float is nearly balanced. H. B.

699. Universal Seismograph. C. F. Marvin. (Monthly Weather Rev. 35. pp. 522-534, Nov., 1907. Paper read before the Amer. Assoc. for Advancement of Science, Dec. 31, 1907.)—After outlining the chief requirements of the various types of seismic recorders, the author describes a universal instrument for recording horizontal movements which he has designed with the object of eliminating as far as possible the deficiencies of present instruments. The inverted pendulum type is chosen, and the "steady mass" made as large as possible, 2,000 lbs. or more. To ensure greater stability the whole of the pendulum is built underground in the mass of the pillar instead of on an erection above ground-level, as is more usual. The motion is transmitted to the recording gear by means of a modification of the spring bow and pulley apparatus, the smoked paper and style being preferred as the recording surface for moderate magnifications, while for high detail the photographic recorder is adopted. Working drawings are given of the details of the pendulum, showing method of rendering the unstable inverted pendulum astatic, the universal gimbal pivot, and the multiplying gear. C. P. B.

700. Elliptic Analyser. C. Zakrzewski. (Acad. Sci. Cracovie, Bull. 9. pp. 1016-1026, Nov., 1907.)—In determining the elements of an elliptic vibration by means of a compensator, a nicol is used to ensure that the ellipse is compensated. The author, in conjunction with C. Kraft, has previously shown [see Abstracts Nos. 1887 (1904) and 1228 (1905)] that instead of an ordinary nicol a combination of a nicol with a double quarter-wave plate (*i.e.*, a plate of which the two halves have their principal directions crossed, in a manner analogous to a Bravais plate) can be used in the process of compensation. The directions of this double plate should make a small angle with the directions of the nicol, which is fixed to the plate. In using the apparatus the compensator is turned until equal intensities in the two halves of the field are obtained. Theory is given and a formula deduced from which the components of an elliptic vibration can be found. The exactitude of the determination of the position of the axes depends on the ratio of the axes of the ellipse. A. W.

701. Critical Stress (Elastic Limit) of Solids. E. Rasch. (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 10. pp. 210-220, 1908. Communication from the Kgl. Materialprüfungsamt, Gross-Lichterfelde.)—It is pointed out on thermodynamic grounds that when dT/dp passes through zero value, a body is at the critical stress, p_k , corresponding to what is usually designated the elastic limit. The argument involves the conception of the production of a certain amount of a yielding phase at p_k . The results of experiments are given in which the variations of temperature (T) during tensile tests were followed by means of a silver-constantan thermo-couple and gold thread Einthoven-Edelmann galvanometer. The elastic limit was sharply defined; the specimens (mild steel and brass) became cooler during the elastic range, and hotter upon stressing beyond the elastic limit. Extensometer measurements gave close agreement with the thermoelectric results. F. R.

702. Tests of Steel Columns. C. P. Buchanan. (Eng. News, 59. pp. 177-178; Feb. 13, 1908.)—A reply to Waddell's discussion of Buchanan's results [Abstract No. 546 (1908)], and gives comparative figures for some of his own, Waddell's and Dagron's results (Dagron, Amer. Soc. Civil Engin., Trans. 20, 1889), as follows:

Observer.	Formula.	Number of Tests.	Average Strength per cent. of Calculated.
Dagron	$P = 61,000 - 268 \sqrt{l/r}$	8	85
Waddell	$P = 47,000 - 178 \sqrt{l/r}$ (carbon steel)	6	98
Buchanan	$P = 47,000 - 178 \sqrt{l/r}$ (carbon steel)	4	95
Waddell	$P = 79,000 - 688 \sqrt{l/r}$ (nickel steel)	6	98

F. R.

703. Outflow from a Circular Orifice. C. Montell. (Ann. des Ponts et Chaussées, 27. 8. No. 85. pp. 189-150, 1907.)—An analytical study of the degree of approximation obtained by the method which is often used by engineers for estimating the flow. Thus the work resolves itself into an investigation as to how closely the usual formula $Q_m = m\pi R^2 \sqrt{2gh}$ (where Q_m is the approximate value, h the height of centre of orifice below the

surface, and R the radius of the aperture) approximates to the value obtained from the more exact formula $Q = 2m \sqrt{2gR^3} \int_0^\pi \sin^3 \phi \sqrt{(h - R \cos \phi)} d\phi$, ϕ being the angle each ray makes with the vertical. In the investigation different values of h and R are considered. It is shown that the degree of approximation depends only upon the ratio h/R , here called α . Further, for larger values of α , Q/Q_∞ is nearly equal to its theoretical value. For $\alpha = \infty$, $Q/Q_\infty = 1$. The ratio Q/Q_∞ is a minimum for a value of α lying between 0 and unity, and increases without limit as one approaches the case where the orifice is a semicircle with centre at the surface level of the water. For this case, viz., $\alpha = 0$, $Q = 0.9584 \sqrt{(2g)mR^3}$. L. H. W.

704. *Gas-flow through Straight Cylindrical Tubes.* Fritzsche. (Zeitschr. Vereines Deutsch. Ing. 52, pp. 81-91, Jan. 18, 1908.)—A research on the resistance offered by straight cylindrical pipes to the flow of gases through them when the velocity of flow is greater than the Reynolds critical velocity. A table is given of the previous important experimental work on the subject from 1819 to 1907. In the present work the effect of (i.) velocity of flow, (ii.) pressure, (iii.) temperature, and (iv.) diam. of tube is considered. If Δp is the pressure-fall per unit length, then the results show that $\Delta p = (0.0864/d^{1.300})(\rho/T)^{0.700} w^{1.300}$ per metre where d is the diam. in m., w the velocity in m. per sec., and T the absolute temperature. A. W.

705. *Measurement of Gas Discharge by Throttle-plate.* A. O. Müller. (Zeitschr. Vereines Deutsch. Ing. 52, pp. 285-290, Feb. 22, 1908.)—This paper describes researches made with the object of determining the contraction coefficient for the discharge of gas through an orifice in a plate. Four cases are considered: (i.) where the gas flows through a circular orifice in the middle of one end of a large cylinder into the open air; (ii.) gas flowing through orifice into a tube 81.9 mm. diam.; (iii.) gas issuing from orifice in end of tube; and (iv.) gas flowing through throttle-plate inserted in the middle of a tube. Various diameters, from 28.4 mm. to 62.25 mm., were taken for the orifice. The contraction coefficient α is defined as the ratio of the minimum diam. (F_0) of the issuing jet to the diam. (F) of the orifice. The mean values obtained for α in the four cases were (i.) 0.597, (ii.) 0.590, (iii.) 0.648, (iv.) 0.636. In the latter two cases α appears to increase slightly with the diam. of the orifice. A. W.

706. *Resistance of Air.* G. Eiffel. (Soc. Ing. Civ. France, Bull. 61, pp. 261-268, Feb. 1908.)—The experiments on the resistance of air at high speeds were made by dropping a weighted surface from the second story of the Eiffel tower along a guide-rope. The connection between the surface and the weight was made by a spring, which registered its compression automatically. A thickening of the guide-rope at the lower end brought the apparatus gradually to a standstill. The results show that, to a first approximation, the resistance may be expressed by the well-known formula $R = K S v^2$, where K is a constant of the mean value 0.074 [see Abstract No. 4448 (1904)]. But, strictly, the value 1.98 must be substituted for the exponent 2 at velocities of 20 m. per sec., and 2.08 at 87 m. per sec. K also increases somewhat with the surface, but appears to tend towards a maximum value of 0.08. A rectangle gives more resistance than a square of equal surface. When the surface is inclined to the direction of motion, the normal pressure

increases from parallelism up to an angle of 80° with the normal to the direction of motion, in proportion with the angle. But after that the pressure does not increase any more. This is attributed to the fact that a normal surface produces a wedge of air in front which acts like a solid. [The experiments are also described in *Engineer*, 105, pp. 889-891, April 17, 1908.]

E. E. F.

707. *The Rolling of Ships.* V. Crémieu. (*Comptes Rendus*, 146, pp. 277-279, Feb. 10, 1908.)—Shows that each vessel has a minimum angle of roll below which we cannot go with any advantage. This angle equals $\nu\theta$, where θ is the inclination of the waves at the point of inflection, and ν is the product of Bertin's three reduction coefficients, and is always below unity. Any further reduction simply transforms the rolling into dancing. Such dancing always accompanies pitching, as the angle of pitching is much smaller than the angle of inclination of the waves. All contrivances for reducing pitching must increase the dancing, but this is an advantage, owing to the long period of the latter.

E. E. F.

708. *The Influence of the Knife-edges in the Reversible Pendulum.* W. Felgentraeger. (*Deutsch. Phys. Gesell., Verh.* 10. 4, pp. 87-90, Feb. 29, 1908.)—In 1906 Kühnen and Furtwängler published work on the determination of "g," in which they point out as a result of experiments that the influence of the knife-edges vitiates results. The present author quotes a paper by himself in 1902, in which the theory of the subject is given and which agrees with this recent experimental work. In place of the well-known pendulum formula, his equation is $K \frac{d^2\phi}{dt^2} + 2C \frac{d\phi}{dt} + S_1 \sin \phi = S_1\phi + S_2\phi^2 + S_3\phi^3$, where K = moment of inertia, $S_1 = Mgh$, ϕ = amplitude. S_1, S_2, S_3 are constants depending on the influence of the knife-edges. In the particular experiments in question the distance between knife-edge and centre of gravity was so small that the time of swing lies between 20 sec. and 95 sec. In this case S_3 becomes of small account and g is found to be independent of S_1 . A question arises whether one is entitled to consider S_1 proportional to h , and if not, how the elastic forces between knife-edge and support are to be allowed for. At least these forces can only depend on the pressure on the support and on the period, the amplitude being small.

P. E. S.

709. *Black Spots in Liquid Films.* G. Bakker. (*Zeitschr. Phys. Chem.* 61, pp. 599-606, Jan. 31, 1908.)—Even in the thinnest black spots some of the homogeneous liquid lies between the two capillary surfaces, as proved by measures of thickness, so long as the capillary surfaces are in contact with saturated steam. Hence the surface tension in thin films is independent of their thickness.

E. E. F.

710. *Meteorological Use of the Polariscopes.* L. Bell. (*Amer. Acad., Proc.* 43, No. 15, pp. 407-412, March, 1908.)—Preliminary note on the use of a simple Savart polariscope, made by the author on Mt. Moosilauke, New Hampshire, 4,811 ft. high, and at the foot station, at Breezy Point, 1,650 ft. Nearly everything in a landscape polarises by reflection, the glossy maple leaves, grass, and trees, stones especially if wetted. Charged aqueous nuclei may exist in unsaturated air at diameters of 1 and 2 μ ; the fog particles giving rise to lunar coronæ have diameters of 20 and 80 μ . Between these lie the

light-scattering particles active in sky polarisation; the author plots curves on their effect after Rayleigh's formula. The process of increasing nucleation likely to result in cloud formation and rain can be studied with the polariscope, as a fall in polarisation indicates progress in nucleation, particularly when the spectroscope shows the presence of much aqueous vapour. H. B.

711. *The Christmas Snowstorms of 1906.* H. R. Mill. (Monthly Weather Rev. 85. pp. 506-508, Nov., 1907. Reprinted from the British Rainfall, 1906.)—On the morning of Dec. 26, 1906, London was covered with 6 in. of snow. The storm was not exceptionally severe, but the author received 1,862 replies to his circulars, and the information collected is more complete than in any previous case. Snow or rain fell on Dec. 25-26 all over Scotland and England, except in the extreme N.E. of Scotland and England and in the extreme W. of Wales, Cornwall, and Devonshire. The area was a belt stretching from N.E. to S.W., and widening from 150 miles in the N. to 200 miles in the S.; it also covered the extreme N.E. of Ireland. The snow fell particularly on the left of the track in its way southward, and was thickest, 8 to 12 in., in the line from Manchester and Leeds to Lincoln and Ipswich. The isochronic lines ran from N. to S. with a slight tendency to diverge to the S.; perhaps they were concentric curves, the centre lying in Ireland, where snow fell in the N. 6 hours before the centre of the depression arrived there. The rate of advance of the storm front was 12½ miles in the N. and 19 miles per hour in the S. At 8 p.m. on Dec. 25 snow began to fall simultaneously along a line 500 miles in length. A second, very severe locally but less universal snowstorm followed on Dec. 27-28. H. B.

712. *Rainfall of South America.* E. L. Voss. (Petermann's Mitteilungen, Ergänzungsheft, No. 157. Abstract by H. Henze in Meteorolog. Zeitschr. 25. pp. 141-142, March, 1908.)—As assistant of the Geographical and Geological Commission of the State of São Paulo, Brazil, the author is collecting material for a climatology; but only a few of the Northern States of South America have answered his inquiries. The statistics are based on reports from 378 stations, covering periods ranging from 1 to 50 years, most of them hardly 5 years. The basin of the Amazon and Southern Chile receive more than 2,000 mm. of rain annually, the Eastern Brazilian States as well as Peru, Northern Chile, and Patagonia less than 500 mm. Summer is mostly the wettest season, winter the driest; some districts have two rainy seasons. The diminution in the annual rainfall and of the length of the rainy season go together. San Juan, in N.W. Argentina, has had one rainless period of 671 days; the Islote de los Evangelistas, in S. Chile, once suffered a rain period of 72 days. The monthly rainfall is greatest in Pernambuco, where in July the mean rainfall is 355 mm., the maximum 1,440 mm., the minimum 58 mm. (29 years' data). The maximum annual rainfall of 5,668 mm. is reported from Alto da Serra; in the same district, on the eastern slope of the Serra do Mar, 22 km. from São Paulo, 417 mm. of rain fell on March 29, 1898. H. B.

713. *Meteorological Observations on the Pic du Midi de Bigorre, Pyrenees, 1894 to 1908.* A. v. Obermayer. (Meteorolog. Zeitschr. 25. pp. 116-125, March, 1908.)—The observations were made on the peak, 2,859 m., and at the low-level station near Bagnère, 547 m., from 1881 to 1896, by F. Klengel, later by Gandy and others, mostly 8 times a day at 8-hour intervals. The

mean barometer for the period 1894 to 1908 is, on the peak, 539.46 mm. (Klengel, 538.24); the extremes are 518.5 Nov., 1908, and 558.8 Feb., 1908. The chief minimum for both stations occurs in March, the chief maximum in July. The diurnal barometric minimum of the peak falls in the morning hours, the maximum in the forenoon, being delayed till the afternoon in the summer. Klengel's mean annual peak temperature was -2.1°C , the later period gives -1.86° ; only in June to Sept. does the mean temperature rise above 0° , but days free from frost may occur in Oct. (8 days a year) and also in the other months. The absolute minimum was -28° (Jan.), the maximum $+19^{\circ}$ (July and Aug.). The mean annual temperature at Bagnère is 10.6° , the coldest month Jan. with 8.6° mean temperature, the warmest Aug. (18°). The fall of temperature with increasing height is less marked and sometimes reversed at high barometer; barometric maxima are generally accompanied by very low relative humidity (10 per cent.). The mean precipitation (rain and snow) on the peak is 1,584.8 mm. (extremes 1,176 and 2,267.5 mm.); Jan. and March are the wettest months; Jan. 3, 1899, received 106.2 mm. of rain, July 3, 1897, 118.8 mm. The mean rainfall at Bagnère is 1,878.2 mm., rain being observed on 184 days and snow on 14 days. Hail is very rare at both stations. The predominating wind on the peak is from S.W. and W.; E. and S.E. are rare. H. B.

714. *The Air-pressure of Low Plains in Relation to Temperature.* W. Trabert. (Meteorolog. Zeitschr. 25, pp. 103-108, March, 1908.)—According to Ferrel the pressure maxima of low plains were due to cylinders of cold heavy air, and the minima to cylinders of warm air. This view became untenable when Hann proved that the high pressure lying for fourteen days over Central Europe in Nov., 1899, had extended to the level of 2,500 m. above the Alps, and that the mean temperature of the air column up to 3,000 m. had been 6° higher than the cold lower stratum some 300 or 500 m. in thickness. The observations made on the Sonnblick further proved that high-pressure periods are distinguished by high temperature. The thermal convection theory of Ferrel then gave way to the dynamical theory. But there are pressure variations in the plains essentially thermal in character. This is shown by the barometric differences in front and in the rear of a thunderstorm, and by the wedges of high pressure north of the Alps, which H. v. Ficker first correctly explained as due to low temperature. Discussing the general circulation on the earth, the author points out that the low barometer of the Tropics and of Central Asia (summer), in addition to the cases mentioned (thunderstorms and Alps), must be essentially of thermal origin. H. B.

715. *Winds of the Great Lake Region of the United States.* A. J. Henry. (Monthly Weather Rev. 35, pp. 516-520, Nov., 1907.)—The author maps out and tabulates the wind directions for the different months and the four seasons as observed at ten stations since 1891 or later. The average wind velocity is about 10 miles per hour; it increases from a minimum in the morning to a maximum in the afternoon, coinciding with the temperature maximum; at Cleveland and Marquette, however, the minimum wind velocity falls in the evening. Storm velocities may reach 80 miles; storms approaching the Lake region from the S. or S.W. are most severe. Storms are rarely equally severe all over the Lakes, but thunderstorms may prevail over the whole region on the same day. H. B.

716. *Lake, River, and Air Temperatures in Southern Russia.* A. Woelkow. (Meteorolog. Zeitschr. 25, pp. 136-137, March, 1908.)—In July and Aug., 1906, Karpowicz and Bode took temperature measurements in the Tambukin Lake, 2 km. long, up to 1 km. wide, shallow water, very salt, with muddy bottom; the lake has no discharge. The Richard thermograph was placed in the middle of the lake, close to the surface. The temperature was mostly very steady, the variation being only 1.3°C . in 24 hours, 2.7° in the extreme case; the mean of 24.9° , e.g., coincided with the temperature at 11 a.m. The air temperature fluctuated much more, and the water was generally warmer than the air (by 7° max.). About the same time E. Bogomolow took temperature observations in the river Dnjepr and in the air near Ekaterinoslav. The river is about 1 km. in width; the temperature was determined in mid-stream at various depths (up to 8 m.), further, in the air, 1 m. above the water; and also in the town, 1 km. away from the river. The air temperature above the water fluctuated much more than the water temperature, which was sensibly the same at various depths (owing to the rapid current) and generally warmer than that of the air; there was not much difference in the air temperature at Ekaterinoslav and that immediately above the river water, contrary to the often expressed opinion.

717. *The Isothermal Layer of the Atmosphere.* C. E. Stromeyer. (Nature, 77, pp. 485-486, March 26, 1908.)—With regard to Dines [see Abstract No. 560 (1908)] the author objects that the real problem is: Why does the isothermal condition of the outer layers of our atmosphere suddenly cease at about 40,000 ft.? The isothermal condition should naturally prevail in an atmosphere surrounding a smooth sphere heated by the sun, in which the lower layers should be the coldest. The mountain ranges prevent the isothermal condition from descending below the height at which effective mixing or moisture-removing occurs. In glacial periods with lower mountain ranges the isothermal layer will have been lower. The author also refers to A. Ritter's views on "Heights of Atmospheres and Conditions of Nebulae," expressed twenty years ago, when the condensability of the permanent gases had not been established. Dewar's researches on the non-conducting power of high vacua lead to the conclusion that the interstellar atmosphere is comparatively warm.—W. H. Dines (Ibid. p. 486) replies that in gases we have to distinguish between "warmer" and "potentially warmer." We have no evidence that the mountain ranges exert any influence on the isothermal layer, and the assumption of an interstellar atmosphere is unacceptable.

H. B.

718. *The Ballons-Sondes at St. Louis.* A. L. Rotch. (Science, 27, p. 315, Feb. 21, 1908.)—Under the direction of the author, balloons have been sent up from St. Louis by S. P. Fergusson from 1904 till Nov., 1907. Only 6 of the 26 balloons have not been recovered. On Oct. 8, 1907, the temperature was -90°F . at 47,600 ft. and -79°F . at the extreme altitude reached of 54,100 ft.; on Oct. 10, the minimum of -80°F . was observed at 39,700 ft., while -66°F . was recorded at 49,200 ft. Thus the inversion had descended by 8,000 ft. in two days. [Compare H. H. Clayton, Abstract No. 558 (1908).]

H. B.

719. *The Isothermal Layer of the Atmosphere.* C. Chree. (Nature, 77, p. 487, March 12, 1908.)—The author cautions one against placing too much reliance on the indications of the thermographs of balloons and kites, con-

sidering the vagaries of self-recording instruments. Dines [see Abstract No. 560 (1908)] mentions that the temperatures found for the isothermal layer at three English stations varied from -42 to -74°F .; an uncertainty of 4°F ., which Dines admits, would not account for this difference, but uncertainties of $\pm 10^{\circ}\text{F}$. would. It does not appear that instruments are tested over the whole range encountered before and after ascents; that different instruments are sent up by the same balloon; and that English and foreign meteorographs are adequately tested as to agreement. H. B.

720. *Balloon Ascent to 26,557 m.* J. Vincent. (Ciel et Terre, Jan. 1, 1908. Nature, 77, p. 445, March 12, 1908.)—A balloon sent up from Uccle, near Brussels, before 7 a.m. (G.M.T.) on July 25, 1907, reached an altitude of 26,557 m. The surface temperature was 12.1°C .; the inversion was well marked. The temperature-fall was arrested at 12,112 m., where -57°C . was recorded; the thermometer rose by 6.7°C . in attaining 18,591 m. An isothermal layer was afterwards met with and the thermometer rose again to -42.2° at 8h. 6min. a.m., when the upper balloon burst. The humidity decreased rapidly after reaching 1,016 m., from 72 to 22 at 1,600 m., to 9 at 3,100 m., and finally to 6. In the inversion layer the wind changed from SSW, to W., finally to SSE, and E. H. B.

721. *Seismic Radiations.* C. G. Knott. (Roy. Soc. Edinburgh, Proc. 28, pp. 217-280, 1907-1908.)—After tracing the progress of early work on the study of seismic wave-fronts, a method is developed which promises to give a working law connecting the speed of propagation of the earthquake wave and the depth below the surface. It is recognised that the records outside the destructive area of a large earthquake consist of two well-marked portions, the "preliminary tremors" and the "large waves," and in all well-developed seismograms the preliminary tremors can be divided into two distinct phases. Regarding these two phases as elastic waves propagated by the earthquake source through the body of the earth by brachistochronic paths with speeds of propagation depending on the elastic contents and density, the analysis of the motion is worked out on the assumptions (1) that the source of disturbance is close to the surface of the globe; (2) that the speed of propagation depends only on the distance from the centre. It is found that the observed facts of seismic radiation can be co-ordinated on the assumption that throughout all but a comparatively thin crust of the earth the elastic waves of highest speed are transmitted with a velocity of 12.28 km. per sec., and that within this crust, of thickness equal to one-tenth the radius, the speed diminishes from value 12.28 km. per sec. at the inner surface to 6 km. per sec. at the outer surface. It is also concluded that it would be possible, though somewhat laborious, to work out the surface distribution of energy for several depths of origin. If this were done, and if instruments could be constructed to give an accurate measure of the energy associated with seismic movements at the surface, we should be in possession of a method for determining the depths of earthquake origins. C. P. B.

722. *The Ziegler Polar Expedition, 1908-5.* C. Chree. (Nature, 77, pp. 544-546, April 9, 1908.)—The author comments on the records of this expedition, published by the National Geographic Society of Washington, D.C., and edited by J. A. Fleming. A. Fiala was commander, W. J. Peters scientific leader of the expedition, which proceeded to Franz Josef Land in 1903; the

ship was lost, and the party rescued in 1905. The results comprise magnetic, auroral, meteorological, and astronomical observations, map construction, and survey work. The chief observations were taken at Camp Abuzzi, Teplitz Bay ($81^{\circ}47'5''$ N. Lat.) from Sept., 1903, to June, 1904; at Camp Ziegler, Alger Island, further south, June and July, 1905; and *en route* from Teplitz Bay to Camp Flora (further south still in the group of islands of Franz Josef Land), the site of the Jackson-Harmsworth expedition. A programme for magnetic work had been laid down by L. A. Bauer, and although they had no recording instruments a great deal was done. Declination needle readings were taken every 24 minutes for 4 hours on one day of a week, for 8 hours on another, and for 4 hours on the remaining four days of the week; the diurnal range was great for the Arctic mid-winter day. More than fifty absolute determinations of horizontal force were made. Magnetic storms and auroræ were generally, but not always, associated; during one storm the declination changed by $17^{\circ}18'$ in 1h. 8m.; about 32 times as much as the corresponding change at Cheltenham, where the horizontal force is three times that at Teplitz Bay. The wind was strong, the mean velocity being 24.6 miles per hour in Dec., 1903; the maximum velocity of Dec. 28 was 78.4 miles; high winter gales were associated with low barometer and high temperature. Temperature-changes were large and rapid. In order to ascertain the tidal range a wooden frame was put round a hole on the ice, and a heavy stone suspended over pulleys from the frame by a rope; this stone rested on the sea-bottom, and the frame rose and fell with the tide and the ice, the movements being measured on a staff attached to the rope. The mean difference between high and low water was 1.188 ft. at Teplitz Bay and 0.966 ft. at Cape Flora. While acknowledging the high value of the observations, the author points out that the difficulties and the short periods of observation render the results somewhat uncertain.

H. B.

723. *The Central Pennsylvania Meteor of Oct. 1, 1907.* H. A. Peck. (Monthly Weather Rev. 36, pp. 508-510, Nov., 1907.)—The meteor was observed about 6.30 p.m. at Syracuse University and reported from localities situated between Toronto and New York. The author analyses the reports. The first appearance was better determined than any other point of its course; the points in whose zeniths beginning and end were observed are on a terrestrial arc 132 miles in length. The nearest approach at the moment of detonation near Halifax, Pa., was 23 miles; four or five bodies connected by a ribbon of light seemed to follow one another; the meteor ceased to be visible at 5 miles from the earth. The path crossed the earth's orbit nearly at right angles; the velocity in space was 27 miles per sec., through our atmosphere 32 miles per sec.

H. B.

724. *Earth as a Radiating Planet.* J. M. Schaeberle. (Science, 27, pp. 392-393, March 6, 1908.)—Resulting from the investigations previously recorded [Abstracts Nos. 208, 209 (1908)] we have the fact that the internal heat of the earth still plays an important, if not controlling, part in all terrestrial phenomena, and it is concluded that without this inherent heat-radiation the terrestrial atmosphere could not exist. Taking the mean absolute surface temperature of the earth as, say, 800°C ., we may regard this as consisting of a surface temperature of 200°C . and an internally stored source at 100°C ., and the radiation into space will be such that the moon receives about $\frac{1}{4}$ th as much heat from the earth as it does from the sun. As the earth is continually growing colder the supply of moisture through surface evaporation is growing

less, and finally the land areas in the polar regions may be completely bare, so that the upper limits of the atmosphere would practically coincide with the surface of a solidly frozen ocean. It is stated that the evidence seems to be almost conclusive that our sun is the parent body of both the sidereal and solar systems. C. P. B.

725. *Illumination of Field of Transit Instrument.* W. H. M. Christie and H. A. H. Christie. (Roy. Astronom. Soc., Monthly Notices, 68, pp. 181-192, Jan., 1908.)—In the determination of clock error when using a reversible transit certain outstanding differences are found which have usually been ascribed to lateral flexure, but this assumption has not been entirely satisfactory. Numerous experiences during longitude work led to the examination of several other possible causes of error, but none of them accounted for the total error. The cause was ultimately traced to the character of the illumination of the wires of the eyepiece reticule. As soon as this was suggested it was apparent that a very variable setting would be possible; at night the wires being seen as dark lines across a bright field, their apparent width will depend on the extent and shape of the illuminating surface. Further experiments confirming this view, a new form of illumination was devised, in which an elliptical finely ground opal glass was used as the reflector, mounted in a brass tube which was attached to the outer surface of the object-glass of the transit instrument. As the source of illumination a small electric lamp is placed in the focus of a condensing lens throwing a beam of parallel rays on the opal reflector, the brightness of the lamp being controlled by means of a rheostat. By increasing the diam. of the pencil of rays it was found that diffraction effects were much decreased and the definition of the wires improved. Tables are given showing the improvement in working by the use of the new arrangement. C. P. B.

726. *Shadow Bands and Scintillation.* C. Rozet. (Comptes Rendus, 146, pp. 325-327, Feb. 17, 1908.)—In a preceding note [Abstract No. 1015 (1906)] the author described his observations on shadow bands at the rising and setting of the sun. Having observed that these phenomena were only produced when the visible part of the sun's disc was very small, he next tried to see if the bands were visible in the case of the bright planets, beginning with Venus. In this case bands were easily seen, but their orientation appeared to follow no definite law. In all cases, however, their direction of motion was perpendicular to their orientation. There appears to be some relation between the character of the bands and the degree of scintillation prevailing at the time; when the scintillation is regular, the screen is crossed by feeble bands, thin and regularly spaced; when scintillation is absent there are no shadow bands. C. P. B.

727. *Objective Prism in Solar Spectroscopy.* E. Schaer. (Astronom. Nachr., No. 4238, p. 187, Feb. 15, 1908. Nature, 77, p. 401, Feb. 27, 1908.)—When a double equatorial is employed, such as those commonly in use for chart stellar photography, the combination may be made to serve as objective-prism spectroscopes. After the light has been brought to focus by the first objective it is reflected twice by means of subsidiary plane mirrors, so that it passes along the second telescope. A slit-plate is adjusted at the principal focus of the first objective. After the light has passed through the prismatic train at the end of the second objective it is reflected back again

along the same path, as in the Littrow spectroscope, and the spectrum is brought to focus near the slit-plate, where it may either be examined visually or photographed by means of a suitable camera.

728. Heat Radiation of the Sun. G. Millochau and C. Fery. (Comptes Rendus, 146. pp. 252-254, Feb. 3; 372-375, Feb. 17, and pp. 661-664, March 23, 1908.)—Description of the apparatus used, consisting of a special type of thermocouple inserted in a metallic sphere about 10 cm. diam. The sphere is so oriented to the sun that the light passes through a small tube on to the pole of the couple, and the deviation is recorded. A curve is then traced, having for abscissæ the times of observation and for ordinates the galvanometer deflections. The strongest deviation yet observed was obtained on the summit of Mont Blanc on Aug. 22, 1907, corresponding to a solar constant of 2.88 calories. Comparison of the solar deviations with those given by a series of electric furnace radiations of known temperatures indicates for the sun a temperature of from 5,567-5,696° absolute. The laws of radiant heat are applied to the interpretation of some of the results obtained, and to the determination of the constants of the pyroheliometric telescope employed.

C. P. B.

729. Prominence and Coronal Structure. W. J. S. Lockyer. (Roy. Soc., Proc. Ser. A. 80. pp. 178-183, March 5, 1908. Nature, 77. pp. 514-515, April 2, 1908. Abstract.)—The routine work with the spectroheliograph of the Solar Physics Observatory since 1904 has been to secure, daily if possible, not only photographs of the sun's disc in the "K" light of calcium, but also of the prominences round the limb at the same wave-length. Many and varied were the shapes of the prominences recorded, some having a pronounced "arched" or "partially arched" form. On July 17, 1907, two photographs were obtained. The first was taken at 8h. 14m. p.m., G.M.T., and the second at 8h. 50m. p.m., G.M.T. The first shows a splendid series of "arches." There are, first of all, three concentric arches, the distance between the extremities of No. 1 being 1'2; No. 2, 3'8; No. 3, 5'8. Their heights from the chromosphere are about 1'5, 2'9, and 3'6 respectively. On the eastern side of these arches is another, distinctly semi-oval in form. This arch intersects two of the concentric ones, and at the point of crossing a more intense patch is indicated. On the southern side are two projections which probably formed the stump of another large arch. The second photograph shows the arches in process of destruction. There are only remnants left, and portions have risen from the chromosphere. This is probably the first time that such a series of concentric envelopes has been photographed with the spectroheliograph.

W. J. C.

730. Planetary Photography. P. Lowell. (Nature, 77. pp. 402-404, Feb. 27, 1908.)—The author describes the recent improvements made at the Flagstaff Observatory, Arizona, by means of which numerous photographs of Mars far surpassing any previous results were obtained during the past year. One of the chief improvements consisted in the camera being arranged to take a long series of images of the planet at very short intervals. By this means the atmospheric disturbances were to some extent avoided, as many of the isolated photographs would be impressed on the plate at moments of specially good definition, whereas if only one or two photographs were taken at a time, the times of good definition might be easily missed. A second improvement consisted in the use of a light-filter specially adjusted to the

particular brand of photographic plates in use, so that the colour transmitted corresponded to that for which the objective had the best colour correction. For the next favourable opposition in 1909 it is intended to photograph a larger image at a greater altitude, so that it is hoped further advances will then be made.

C. P. B.

731. *Dark Spots on Jupiter.* S. Bolton. (Soc. Astronom. de France, Bull., Jan., 1908. Nature, 77, p. 401, Feb. 27, 1908. Abstract.)—Describes a number of Jovian details observed during recent years, special attention being drawn to a series of uniformly distributed dark markings along the northern edge of the south equatorial belt, and also along the southern edge of the north equatorial belt. As the spots occur in about the same longitude and have a common motion, the author concludes that they are real. The alternate spots on the opposite bands are joined by festoons of dark material crossing the equatorial regions obliquely at angles of 45° .

C. P. B.

732. *The Possibility of Life on Mars.* J. W. Evans. (Nature, 77, p. 413, March 5, 1908.)—If the temperature of our atmosphere remains practically constant at -47° C. after a height of 85,000 ft. has been reached [compare Dines, Abstract No. 560 (1908)], and similar conditions prevail on Mars, then, accepting the calculations of Jeans ("Dynamical Theory of Gases"), hydrogen would be lost, helium probably be retained, and water vapour certainly be retained by Mars. The isothermal layer of Mars will, however, be much colder than that of the earth, because the carbon dioxide of Mars will be concentrated in its lower levels. Neither Lowell nor R. Wallace seems to have realised the importance of CO_2 for the surface temperature. More heat is "retained" where much CO_2 is present in the atmosphere, and vegetation may well be maintained on Mars, as Lowell assumed.

H. B.

733. *Habitability of Mars.* P. Lowell. (Nature, 77, p. 461, March 19, 1908.)—This is a reply to the opinions expressed by Wallace in his book. He shows that as the south snow cap comes down to 36.5° latitude on the average, this will provide an area of 11,880,000 sq. miles of snow. The canal system covers some 4,750,000 sq. miles, so that when the snow melts we may have a depth of quite $2\frac{1}{2}$ ft. The argument for temperature is equally erroneous, as the effect of blanketing has been taken into account. The theory of Wallace as to Mars having completely lost all internal heat is considered invalid, for it can be shown that Mars could not have captured any meteoric swarms not travelling in its own orbit when it coalesced into a planetary mass. G. Johnstone Stoney (Ibid. pp. 461-462) contributes a few remarks concerning the evidence for thinking that certain gases can effect their escape from planetary atmospheres, and of the weight such evidence has on the theory of constitution of the atmosphere of Mars. Mention is made of the failure of various observers to detect water vapour on Mars, suggesting that its visibility is variable.

C. P. B.

734. *Presence of Water Vapour in the Atmosphere of the Planet Mars.* P. Lowell. (Comptes Rendus, 146, pp. 574-575, March 18, 1908. Extract from a letter.)—Early observers (Huggins, Janssen, Vogel) on recognising the bands of water vapour in the spectrum of Mars, admitted the presence of the vapour on the planet. But at a later date Keeler and Campbell remarked that the airless moon, when in the vicinity of Mars, showed the same bands

quite as intensely, and they therefore assigned a terrestrial origin to these bands. Researches on the subject at Flagstaff at first, with ordinary photographic plates, gave no definite results. But recently the author and Slipher have succeeded in preparing plates sensitive to the extreme red, and capable of giving with 2 or 3 hours' exposure the spectrum of Mars in the region of the a band, which is much the most intense of the water-vapour bands. In Jan., 1908, they obtained spectra of Mars which show the a band clearly, while the spectrum of the moon, photographed on the same plate, shows no trace of it. Yet on Jan. 15, to take an example, the altitude of Mars above the horizon was 48° , and that of the moon only 80° . The author infers that water vapour is certainly present in the atmosphere of Mars. A. E.

735. Saturn's Ring during Disappearance, Oct.-Nov., 1907. R. T. A. Innes. (Roy. Astronom. Soc., Monthly Notices, 68, pp. 209-210, Jan., 1908.)—Observations made with a 9-in. Grubb refractor at the Johannesburg Observatory, using a high-power concave eye-lens, showed that the ring appeared as a ghost-like extension, tapering off sharply, and clearly seen to be discontinuous on Nov. 21. Two cloud bands were visible on each side of equator, and there was some suspicion that the shadow of the ring on the planet was divided into two lines. C. P. B.

736. Dispersion of Light in Interstellar Space: Application to Determinations of Stellar Distances. C. Nordmann. (Comptes Rendus, 146, pp. 680-688, March 30, 1908.)—After some general remarks on the processes adopted by Tikhoff and himself in their recent investigations of the dispersion of light in celestial space [see Abstracts Nos. 590, 591 (1908)], the author gives the approximate distances from the earth of the stars observed for the investigations, as calculated from the results (which, however, are to be regarded as provisional and uncertain). Pritchard's value, $0''.0558$, for the parallax of Algol, obtained from measures of photographs, and the dispersion formula $n = A + B/\lambda$, were assumed in the reductions.

Star.	Interval of Spectrum Studied.	Order of Magnitude of Distance from Earth.
α Tauri	450 to 680 $\mu\mu$	180 light-years
β Aurigæ	400 " 450	95 "
Algol	450 " 680	80 "
W Ursæ Maj.	380 " 625	25 "
RT Persei	480 " 560	15 "

The author calls attention to the importance in this connection of obtaining a more exact value for the parallax of Algol, and of investigating the parallaxes of W Ursæ and RT Persei. The comparatively small values obtained for the distances of the two last stars give hope of a successful result. A. E.

737. Eccentricities of Visual and Spectroscopic Binary Stars. T. J. J. See. (Roy. Astronom. Soc., Monthly Notices, 68, pp. 201-202, Jan., 1908.)—Excluding from consideration all binaries telescopically resolvable in modern instruments, there remain about 80 orbits of purely spectroscopic binaries, the elements of whose orbits have been worked out from spectrograms taken chiefly at the Lick, Yerkes, and Potsdam Observatories. The eccentricity is

well-determined, and the average value for these 80 systems is about 0.22. In the case of very rapid binaries, with periods often much less than a day, the orbits are practically circular. The average eccentricity of visual binary star systems is about 0.50, i.e., considerably more than twice that found among the purely spectroscopic class.

738. *Orbit of η Virginis.* N. Ichinohe. (Astrophys. Journ. 26, pp. 282-291, Nov., 1907.)—A discussion of the observational material and plates at present available. The magnesium line $\lambda = 4481$ is as strong as H γ , while the silicon lines $\lambda\lambda 4128$ and 4181 are well shown. The spectrum of the faint component is an exact duplicate of the bright companion. It is thought that the faint component is not only a companion to the principal star, but that there is at least one other component still nearer to the principal.

L. H. W.

739. *Photographs of Comet Daniel (1907d).* M. Wolf. (Roy. Astronom. Soc., Monthly Notices, 68, pp. 180-181, Jan., 1908.)—Description of results obtained on 1907 July 21, 22, Aug. 2, 4, 7, 8, 9, 11, 14, 27, with various instruments. The most striking result appears to be the differences between the visual and photographic outlines of the comet. All the drawings show a minimum of luminous radiation in or around the axis of the tail in the region turned away from the sun. All the photographs show the brightest tails near the axis. There is also a further important fact shown in that the short arms of the tails furthest outside the axis are nearly all curved, although this is in opposition to accepted theories.

C. P. B.

REFERENCES.

740. *The Dynamics of Long Recoil.* A. G. Greenhill. (Engineer, 104, pp. 184-185, Aug. 23, 1907.)—Deals with the case of the recoil of field travelling carriages of guns having controlling buffers.

741. *Lateral Vibration of Bars supported at Two Points with One End overhanging.* J. Morrow. (Phil. Mag. 15, pp. 497-499, April, 1908. Paper read before the Physical Soc., Nov. 8, 1907.)—[See Abstract No. 24 (1907).]

742. *On Induced Stability.* A. Stephenson. (Phil. Mag. 15, pp. 233-236, Feb., 1908.)—The influence of the disturbance [Abstract No. 1451 (1907)] on instability of equilibrium is here examined in connection with the problem of the inverted pendulum.

743. *Water-hammer.* Goupil. (Ann. des Ponts et Chaussées, 25. 1, pp. 199-221, 1907.)—Deals at length with the work of N. Joukovsky (Acad. Sci. St. Pétersbourg, Bull., 1898), which was published in Russian and hence has hitherto been unavailable to many workers.

L. H. W.

744. *Number of Corpuscles in the Atom.* J. Bosler. (Comptes Rendus, 146, pp. 686-687, March 30, 1908.)—By consideration of the life and radio-activity of a gramme of radium it is concluded (in harmony with J. J. Thomson) that the number of corpuscles in an atom of hydrogen is of the order unity.

745. *Theory of Surface Forces. III. Physical Meaning of the Unstable Part of the Isotherm of James Thomson.* G. Bakker. (Phil. Mag. 15, pp. 413-431, April, 1908.)—[See Abstracts Nos. 209 and 3015 (1907).]

746. Distribution of Molecular Velocities. O. Postma. (Konink. Akad. Wetensch. Amsterdam, Proc. 10, pp. 390-407, Jan. 28, 1908.)—Deals with the motion of molecular systems on which no external forces act by a method similar to Poincaré's treatment of the problem of small planets. E. E. F.

747. Capillarity by Means of Adhesion Plates. T. Lohnstein. (Ann. d. Physik, 25, 4, pp. 807-818, March 31, 1908.)—Previous work has been done by Gallenkamp [Abstract No. 379 (1903)], and by Quincke who criticised Gallenkamp's work [see Abstract No. 1181 (1903)]. The present paper gives a theoretical discussion of the determination of the capillarity constant by means of adhesion plates, and shows that Gallenkamp's conclusions were not reliable, since in his work the angle of contact was taken to be zero, which is not the case. A. W.

748. Relation of Movements of High Clouds to Cyclones in the West Indies. J. T. Quin. (Monthly Weather Rev. 35, pp. 510-511, Nov., 1907.)—Further arguments against the conclusion of Viñes that a superior general current comes from the eastern quarter during the hurricane season [compare Abstract No. 1797 (1907)]. H. B.

749. Foehn Effects in Southern California. A. G. McAdie. (Monthly Weather Rev. 35, p. 508, Nov., 1907.)—A well-marked Foehn with great diurnal ranges of temperature was observed on Nov. 29 to Dec. 1. The max. temperature ranged from 80 to 85° F. throughout Northern California on Dec. 1; the morning was cold, with frost in many places, giving a range of 54° F. in 14 hours. The influence of radiation is dwelt upon. H. B.

750. Meteorological Observations at the High-level Stations of Southern India, 1906. J. Hann. (Meteorolog. Zeitschr. 25, pp. 28-31, Jan., 1908.)—An analysis of the Annual Report of the Director of the Kodaikānal and Madras Observatories for 1906. References are made to previous years and to other stations, and the figures of the tables are reduced to the metric system. The wind force is to be dealt with in a further paper. H. B.

751. Waterspouts on Swiss Lakes. J. Fröh. (Jahresber. d. Geograph.-ethnograph. Gesell., Zürich, pp. 105-107, 1906-1907. Abstract by R. deC. Ward in Science, 27, p. 475, March 20, 1908.)—A detailed account is given of the waterspout seen June 19, 1905, on the Lake of Zug. It was a hollow column, about 20 m. in diam. and 1 km. in height, with left-handed rotation. Twenty-two other waterspouts are mentioned, of which 14 occurred in the summer months. There is no evidence that the spouts were produced by the meeting of winds of different directions. H. B.

752. Theory of Vortex Motion and the Waterspout at Cottage City, August 19, 1896. I. and II. F. H. Bigelow. (Monthly Weather Rev. 35, pp. 464-480, Oct., 1907.)—The theory is applied to the funnel-shaped and to the dumbbell-shaped types, both of which were represented in the Cottage City waterspout. Reference is made again to the International Cloud Report, and it is now attempted to determine the constants and velocities. The series is to be continued [see Abstracts Nos. 190, 581, 791, 798 (1907)]. H. B.

753. Catalogue of Sun-spot Lines. W. S. Adams. (Astrophys. Journ. 27, pp. 45-65, Jan., 1908.)—Contribution from the Mount Wilson Solar Observatory, No. 22.—List of lines specially affected in the spectra of sun-spots, reduced from photographs taken with the Littrow spectrograph of 18 ft. focal length, and a Rowland grating of 14,488 lines to the inch, second order spectrum. The present table includes the region $\lambda 4000$ to $\lambda 4500$. C. P. B.

754. *Recent Earthquakes.* J. Milne. (Nature, 77. pp. 592-597, April 28, 1908. Discourse at the Royal Inst., March 20, 1908.)

755. *Choice of Stellar Declination for determining the Azimuthal Constant, the Collimation, and the Error of the Clock.* G. Zappa. (Accad. Lincei, Atti, 18. pp. 621-630, Nov. 3, 1907.)—A mathematical paper in which it is shown that, using the instrument in the meridian without inversion, much greater accuracy is attainable in the determination of these values by the selection of suitable stars for the purpose. W. H. St.

756. *Orbits of certain Spectroscopic Binaries.* H. D. Curtis. (Astrophys. Journ. 26. pp. 263-276, Nov., 1907.)—The binaries dealt with are θ Draconis, α Carinae, κ Velorum, and α Pavonis. A. B. Turner. (Ibid. pp. 277-281.)—Deals with the orbit of ω Draconis. N. Ichinohe. (Ibid. pp. 157-163, Oct., 1907.) A consideration of μ Sagittarii.

757. *Age of a Cooling Sphere.* G. F. Becker. (Science, 27. pp. 227-233, Feb. 7, 1908.)—Review of the various theories which have been propounded for determining the age of a cooling globe in which the initial temperature increases directly as the distance from the surface. As the result of the author's analysis he concludes that a period of 60 millions of years represents the earth's age, and that this is in accord with geological estimates from denudation and sedimentation. [See also Abstract No. 24 (1908).] C. P. B.

758. *Transit of Mercury, 1907 November 14.* R. T. A. Innes. (Roy. Astronom. Soc., Monthly Notices, 68. pp. 128-129, Dec., 1907.)—Using a 9-in. Grubb refractor at the Johannesburg Observatory, the planet was observed during transit through passing clouds. Times of ingress and egress are given, with comparison times by other observers with different instruments. C. P. B.

759. *Ephemerides of the Planetoid Prologeneia (147).* M. Žilova. (Acad. Sci. St. Pétersbourg, Bull. 6. pp. 537-547, April 1, 1908. In German.)—Ephemerides for the 9 oppositions in the years 1910-1920 are given.

760. *New Satellite to Jupiter.* P. Melotte. (Astronom. Nachr., No. 4287. p. 207, March 6, 1908. Nature, 77. p. 470, March 19, 1908.)—A peculiar moving object was discovered on plates taken with the 30-in. equatorial reflector at Greenwich, on Jan. 27, 1908, of about the 16th magnitude. It has been observed on seven nights since that date, and observations of it have also been made by Wolf at Heidelberg. C. P. B.

761. *Visibility of Saturn's Ring.* M. Amann. (Comptes Rendus, 146. pp. 323-325, Feb. 17, 1908.)—Notes on the visibility of the side of Saturn's ring not lit up by the sun. Observations made with the equatorials at Aosta, 170 mm. aperture and 108 mm. aperture. Effect possibly due to ring being composed of small particles, and thus partly transparent. C. P. B.

762. *System of ζ Ursæ Majoris.* E. B. Frost. (Astronom. Nachr., No. 4235. p. 171, Feb. 29, 1908. Nature, 77. p. 471, March 19, 1908. Abstract.)—Note confirming Ludendorff's observation of the variable radial velocity of the fainter component of ζ Ursæ Majoris (Mizar), but stating that the photographs taken at Yerkes show a greater range of velocity, varying from -17 km. to $+10$ km. per sec. Evidence is also obtained that Alcor, the bright companion to Mizar, also shows variable radial velocity. The displacement of the magnesium and titanium lines is not equal. C. P. B.

LIGHT.

763. Spectrophotometry. J. Thoveri. (*Comptes Rendus*, 146. pp. 534-535, March 9, 1908.)—Describes a device for bringing into sharp juxtaposition the fields due to the two sources of illumination. These both cover the entire opening in a diaphragm on the collimating lens, but, in the focal plane of the eyepiece, a small-angle prism occupying half the height separates the two illuminating beams.

E. H. B.

764. The Absorption of some Gases for Light of very Short Wave-length. T. Lyman. (*Astrophys. Journ.* 27. pp. 87-106, March, 1908.)—An investigation into the absorption exerted by certain gases for very short wave-lengths, undertaken with the vacuum grating spectrograph. The gases were He, A, N₂, O₂, H₂, CO, and CO₂. The length of the absorption chamber was 0.914 cm., and the apparatus was connected with a mercury pump and gauge so that the pressure could be varied. The region studied was between $\lambda = 1850$ and $\lambda = 1250$, and the following results were obtained. H₂, A, and He give no measurable absorption in the above region, while N₂ gives a slight but very perceptible absorption. The absorption given by O₂ and the two oxygen compounds is especially interesting, as it is selective. In the case of oxygen, with thickness as given above and atmospheric pressure, the absorption band extends from $\lambda = 1760$ to $\lambda = 1270$. With change of pressure this band broadens unsymmetrically, this effect being greatest on the less refrangible side of the band. The author has shown that ozonisation of oxygen is brought about by light of very short wave-length, this effect increasing with decrease of wave-length. The source of light used was the hydrogen vacuum tube, such as was used for the absorption experiments. The absorption of CO presents eight bands with maxima at $\lambda = 1548, 1512, 1482, 1450, 1423, 1395, 1370, 1345$. These do not correspond with any emission maxima, and they decrease in width with decrease in wave-length. They are still visible when the pressure is reduced to 0.1 atmo. CO₂ exhibits absorption beyond $\lambda = 1600$ but the more refrangible limit has not been discovered, owing very possibly to the absorption exerted by the fluorite windows. The absorption curve is not smooth, and suggests the presence of narrow bands, two of these agreeing with two of those of CO.

E. C. C. B.

765. Axial Colours of the Steam-jet and of Coronas. C. Barus. (*Amer. Journ. Sci.* 25. pp. 224-226, March, 1908.)—These colours overlie the source of light when looked at through a long column of wet air in which uniform cloud particles are suspended. It makes no difference whether the source is a point or a disc; it appears uniformly coloured as if seen through coloured glass, as long as the cloud lasts. The order of colours beginning with particles of extreme smallness is the same as that of Newton's interferences, seen by transmitted light. In the case of the steam-jet, however, on passing the transition from crimson to violet in the first order, the field becomes opaque, while the steady flow of the jet usually breaks down and becomes turbulent. In the case of coronas this transition has not been observed, mere fogs of uncertain character being seen. To produce the actual colours vividly, and especially the tints of the second and third orders for relatively

large particles, the columns of fog must be long and very uniform. The steam-jet soon fails in this respect, but a drum 1 to 2 m. long used as a fog chamber shows saturated colours surrounded by coronas. In the case of hydrocarbon vapours the columns may be shorter, because the particles throughout are larger for like numbers per cm^3 than is the case with water vapour. Previously the author was inclined to regard these colours as interferences superimposed on the coronas, but this explanation is not satisfactory. Neither is the explanation of the disc colours to be found from the analogy with the case of a lamellar grating in which diffractions are obtained from a uniform succession of alternately different thicknesses of clear glass, as investigated by Quincke and Verdet. An explanation of the phenomena observed has not yet been arrived at. J. J. S.

766. Anomalous Dispersion of Metallic Vapours. H. Erfle. (Deutsch. Phys. Gesell., Verh. 10. 8. pp. 35-53, Feb. 15, 1908. Physikal. Inst. d. techn. Hochschule, München, Jan. 4, 1908.)—In the absorption bands of a metallic vapour both the refractive index and the absorption may attain values far beyond those found in solid and liquid bodies. This conclusion follows both from Drude's theory and from the Planck-Lorentz theory. But it does not exclude the possibility of refractive indices less than unity. The dispersion in the absorption band surpasses that of all solids and liquids. Thus, according to Planck's theory, in the small interval between 588.988 and 589.000029 μ the refractive index jumps up from 0.00047 to 45.6, and the maximum modulus of extinction at the latter wave-length is 45.6. E. E. F.

767. Surface Brightness of the Sky and Illumination of Interiors. K. Kähler. (Meteorolog. Zeitschr. 25. pp. 52-57, Feb., 1908.)—In this article the author describes a series of experiments dealing with the intensity of daylight illumination in buildings, including measurements of the actual surface brightness of the sky itself. These tests may be made with a Weber photometer, a modified form of the instrument including two rotating nicols being found most convenient for the latter purpose. Observations were taken, under different meteorological conditions, of the brightness of different parts of the sky. It was found that this brightness naturally varied very greatly on different days, and that no definite unvarying relation could be detected between the brightness of the sky at the zenith and that at any particular angle of the horizon. The author also explains the method of calculating the intensity of illumination due to a given window in terms of the surface brightness of the sky illuminating it, and gives a table in which the theoretically calculated and observed results are placed side by side and found, considering the difficulties of experiment, to agree comparatively closely. L. G.

768. The Photochemical-Intensity Exposure Law. A. Becker and A. Werner. (Zeitschr. wiss. Phot. 5. pp. 382-391, Nov., 1907.)—Busson and Roscoe found that for AgCl the photochemical effect was proportional to I ; Michalke and Abney, for AgBr, that smaller intensities and proportionately increased exposures gave reduced photochemical effects; Schwarzschild found, for AgBr-gelatine (ordinary undyed plates), that the density obtained was uniform when the product $I\theta$ was maintained the same; θ being a constant for each brand of plate (Lumière 0.96, Schleussner 0.89, Smith 0.97, Wratten 0.83, Schattner 0.86). The authors find, for blue-violet, green, and red respectively, development 80 sec. with rodinal 1:20, the values of θ are:

Schleussner 0.921, 0.900, and 0.901; Agfa film 0.917, 0.914 (red no. effect); Perorito film Perutz, 0.783, 0.776, and 0.789; Wratten and Wainwright pinacol plate, 0.864 (green not given) and 0.888. The value of θ therefore varies little with λ ; and it tends to higher value, as the sensibility of the plate increases. A. Werner (Ibid. 6. pp. 25-29, Jan., 1906) gives for dyed plates the following values of θ : Vogel-Obernetter, silver eosin (Perutz), 0.88; Lumière (orthochromatic A), 0.86; Wratten and Wainwright (pinachrome bathed) 0.78; Perorito plate (Siegel green, Perutz) 0.88; Perorito film (Siegel green, Perutz) 0.79. These low values of θ disqualify dyed plates for stellar photography. θ depends also on the age of the plate and the condition of the emulsion; scarcely at all on the concentration of the (rodinal) developer; and falls with increasing temperature of the developer (0.81 at 5°, 0.75 at 30°) and with prolongation of the development (0.82 at 25 sec., 0.76 at 3 min.).

769. *Autochrome Plates.* E. Stenger. (Zeitschr. wiss. Phot. 5 pp. 372-382, Nov., 1907.) Photochem. Laborat. d. kgl. techn. Hochschule, Charlottenburg, Aug., 1907.)—Lumière's "autochrome" plates are described. The spectrum sensitiveness curves for (a) the bare sensitive film and (b) the plate exposed through the coloured starch grains, each with and without the yellow screen, are much like those of isocol-dyed plates. There is a considerable fall off in the sensitiveness at the blue-green. Underexposures start (at the normal exposure) with the orange-red 590-620 μ , then at (at $\frac{1}{2}$ normal) with green 550, then (at $\frac{1}{4}$ normal) with blue 440-475 μ . As the exposures increase, these regions spread; green begins to overlap orange-red at $\frac{1}{4}$ normal exposure, forming yellow; but not until $2\frac{1}{4}$ normal exposures does the gap between blue and green disappear. Without the yellow filter the blue begins first. The gap between green and blue under normal exposures prevents perfectly accurate reproduction of colours.

770. *Photographic Fog.* A. and L. Lumière and A. Seyewetz. (Zeitschr. wiss. Phot. 5. pp. 392-394, Nov., 1907.)—An unexposed plate will fog in the developer where an exposed one will give an unfogged negative. Fog begins in the former case (water 1,000 gm., diamidophenol 5 gm., anhydrous Na_2SO_4 30 gm., 18° C.) in between 1 and 2 min., in the latter not for 10 min.; 25° C. instead of 18° promotes fog from the 2 $\frac{1}{2}$ min. onwards, and in 10 min. the exposed plate is as much fogged as the unexposed. The fog is always greater the shorter the exposure to light. The exposed plate forms KBr in the developer: this acts as a restrainer and retards fog; and if this amount of KBr be added, the unexposed plate fogs no more rapidly than an exposed one. Old plates seem to lag in the production of bromide; for both exposed and unexposed act like unexposed, and soon fog.

771. *Photography. Reversible Pictures. Integral Photographs.* G. Lippmann. (Comptes Rendus, 146. pp. 446-451, March 2, 1908.)—Compare an observer passing a photograph of a landscape suspended in its frame, with one passing a window through which the same landscape can be seen: in the latter case the view changes with the point of view. Can a photograph be made so as to produce the latter effect? It seems that it could. Suppose a celluloid film moulded so that its anterior surface presents numerous small bosses, each a spherical segment, and its posterior surface a corresponding series of spherical bosses, flatter, but each having the same centre of curvature as the corresponding anterior boss, the radius of the front boss being ($n-1$)

times the radius of the back boss, where n is the index of refraction of the celluloid; and let the back surface be coated with sensitive emulsion, preferably with black pigment separating the numerous small lenses from one another. Each little cellule corresponds to a single eye, and the whole recalls the eye of some insects. The whole acts as an assemblage of small cameras, which can produce a multitude of microscopic images. These images, looked at directly after exposure and development, would produce no impression on the eye beyond that of a uniform grey; but if the pellicle be looked at from the front side, the eye will perceive, by transmitted light, a single resulting image projected in space, and of the natural size of the original objects, every point being seen in one or other of the cellules under its original angle of view. As the position of the eye changes, the field of view changes; and as each eye has its own field of view, the effect is stereoscopic. To get the relations of right and left, up and down, correct, (1) develop the exposed film so as to make it a positive instead of a negative, and turn this in its own plane through 180° , or else (2) develop in the usual way and photograph this negative on a similar embossed pellicle held at some cm. distance from it, so as to produce a positive. The diam. of each cellule must be less than the diam. of the pupil of the observer's eye. Moving the head to one side, the points of the view seen are those photographed on the periphery of the retina of each cellule; thus the view comprehends a sweep of the horizon just as on moving past a window, and the view is panoramic. A cylindrical pellicle could take in the whole 360° ; a spheroidal one would give sky, horizon, and foreground in true relations. All errors due to the imperfections of the little lenses are compensated by reversal. The difficulty of stamping the film to correct proportionate radii of curvature is of a technical order merely: glass might be moulded to proper forms. If we could get glass of $n = 2.00$, the two faces might be identical, the cross-section of each cellule being then spherical, with the necessary material to bind contiguous spheres into a sheet.

A. D.

772. *Röntgen Rays: Coin Images.* C. Jensen. (Ann. d. Physik, 25. 2. pp. 185-204, Feb. 7, 1908. Physikal. Staats-Laborat., Hamburg, Dec. 10, 1907.)—Further observations on coin images [see Abstract No. 658 (1907)] produced by directing Röntgen rays through coins to a photographic plate; reversals of effect with silver and metals of the platinum group; traceable to secondary radiations in the metal and in the material underlying the photographic plate, and possibly also to tertiary radiations. Becquerel and radium rays do not produce these effects.

A. D.

773. *Liquid Crystals in Polarised Light.* E. Sommerfeldt. (Phys. Zeitschr. 9. pp. 284-285, April 1, 1908. Mineralog. Inst. d. Univ., Tübingen, Jan. 25, 1908.)—An account of observations on the optic pictures formed in the case of liquid crystals at the temperature of the room, plates of ammonium and potassium being used. The ammonium salt is more transparent than the potash salt, and when pure is seen to be uniaxial. The double refraction is increased when the two salts are mixed, and with this liquid mixed crystal the first coloured ring with complete interference colours of the first order was brought into the field of view.

J. J. S.

774. *Spectrum Series.* G. A. Schott. (Nature, 77. p. 413, March 5, 1908.)—The electrical theory of dispersion is based on the hypotheses (1) that electric waves are due to motions of electric charges, and waves of light in particular

to vibrations of charges inside the atom; and (2) that these vibrations are governed by linear equations. On this basis the usual dispersion formulae are obtained, e.g., that of Drude: $n^2 - 1 = \sum \left[\frac{N_A e^2}{m \lambda^2} \left\{ \frac{\lambda_0^2}{\lambda^2 - \lambda_0^2} \right\} \right]$, where n is the refractive index for wave-length λ , λ_0 is one of the free periods of a set of electrons in the atom, e , the charge, m , the mass, and N_A the number per cm.³ of the electrons of the set, while the summation is for all possible free periods of the atom. If λ is greater than every one of the free wave-lengths of the atom, this gives $n^2 - 1 > \sum N_A e^2 \lambda_0^2 / m \lambda^2$. From this it is shown that the contribution of all the lines of the Balmer series to the dis-

persions of hydrogen exceeds $A \sum_{m=3}^{\infty} m^2 / (m^2 - 4)^2$, where A is the least value

of $N_A e^2 \lambda_0^2 / m \lambda^2$. The sum is obviously infinite; but all experience shows that for long waves the refractive index of hydrogen is nearly unity, and finite even for luminous hydrogen. The same result follows for any series formula which implies that a series has (1) a tail; (2) an infinite number of lines, the wave-length of which exceeds that of the tail, that is, for all known formulae which agree with measurements either of line or of band series. So it appears that we must either reject the usual notion of a series, and with it all the formulae which represent experience best, or we must reject the hypothesis that series lines are due to small vibrations of electric charges governed by linear equations, and with it the usual theories of dispersion and absorption, of the Zeeman-effect and of magnetic rotation for series lines. **N. R. Campbell** (*Ibid.* pp. 607-608, April 30.) A. W.

775. *Measurements of Wave-lengths for the Establishment of a System of Standards for Spectroscopy.* **H. Buisson** and **C. Fabry**. (*Journ. de Physique*, 7. pp. 189-195, March, 1908.)—The measurement of a series of 115 lines, mainly in the arc spectrum of iron, by interference methods, to serve as spectroscopic standards. As laid down by the International Congress the primary standard is that of Cd $\lambda = 6488.4696$ angströms, and the lines are not more than 50 angströms apart, the angström being defined by the value of the red Cd line. The experimental method and the apparatus are described in full in the paper. In certain regions of the iron spectrum where it is weak the list is supplemented. Four Ni lines are given in the yellow, two Mn lines in the blue, and four Si lines in the extreme ultra-violet. Fourteen of the lines have been previously measured by Fabry and Perot, and the numbers obtained in the previous case are extraordinarily close to the ones in the present paper. E. C. C. B.

776. *Neo-erbium.* **K. A. Hofmann** and **O. Burger**. (*Ber. Deut. Chem. Gesell.* 41. p. 308, 1908. *Chem. News*, 97. pp. 145-146, March 27, 1908.)—A description of a refractionation of erbium until it possessed an atomic weight of 167.48, beyond which no further change could be produced. The absorption spectrum of the aqueous solution is somewhat simplified as the bands at $\lambda = 648, 549$, and 458 have disappeared. A good way to observe the absorption spectrum is to focus the light from an arc by means of a quartz lens upon the solid oxide and to examine the reflected light. E. C. C. B.

777. *Absorption Spectra of Collidine and 9-Chlor-collidine.* **J. E. Purvis** and **W. H. Foster**. (*Cambridge Phil. Soc., Proc.* 14. pp. 381-384, March 10, 1908.)—The absorption spectra of 9-chlor-collidine and collidine were

observed with a view to finding out where the nine chlorine atoms of the former had entered the molecule. In the case of the collidine it was found that the absorption band had slightly less persistence than lutidine, and was also nearer to the red. This thus falls into line with Baker and Baly's observations on pyridine and lutidine. The 9-chloro-collidine gave a band slightly nearer to the red, but also of less persistence than the parent collidine. From this it is argued that the 9 chlorine atoms have simply replaced the hydrogen atoms of the three methyl groups. [See Abstract No. 244 (1908).] E. C. C. B.

778. *Phenomenon attributable to Positive Electrons in the Spark Spectrum of Yttrium.* J. Becquerel. (Comptes Rendus, 146. pp. 688-685, March 30, 1908.)—In the spark spectrum of yttrium two groups of lines are specially noticeable, beginning at wave-lengths $597.05 \mu\mu$ and at $618.10 \mu\mu$ respectively. The author has observed 8 lines in the first group and 7 lines in the second; the last lines of each group being very faint. He also finds that the lines of the second group (618.10) give the Zeeman phenomenon in the habitual sense, while the lines of the first group (597.05) present the phenomenon in the inverse sense, and may, therefore, be attributed to positive electrons. [See also Abstracts Nos. 610 and 618 (1908).] E. H. B.

779. *Spectrum of Magnesium and of the so-called Magnesium Hydride, as obtained by Spark Discharges under Reduced Pressure.* E. E. Brooks. (Roy. Soc., Proc. Ser. A. 80. pp. 218-228, March 5, 1908.)—A study of the spark spectrum of Mg as obtained under different conditions. One of the discharges, called the high-frequency flame discharge, is obtained as follows: A spark coil was shunted with two large Leyden jars of total capacity about 0.004 mfd. and an auxiliary spark-gap of from $1/16$ to $1/8$ in. was put in series with the discharge vessel. The electrodes were made of thin spirals of commercial Mg-ribbon; the coil was fed with from 10 to 16 amps. from alternating mains at frequency 50, no contact-breaker being employed. The pressure was reduced to about $3/16$ in., and after the current had been passing some time the above type of discharge was developed, its appearance being that of a green glow surrounding the electrodes and bridging the spark-gap. This discharge shows the hydride fluting whatever be the surrounding gas, but in the complete absence of H_2 or H_2O vapour it disappears. The spectrum of this discharge (in an atmosphere of H_2) shows the gas lines, though not too obtrusively, and also the 4481 line very intensely. Amongst other lines are to be seen two pairs at 4438.6 and 4428.2, and at 4990 and 4885 [see Abstracts Nos. 1848 (1902) and 2877 (1904)]. The low-frequency discharge obtained without jars is quite different from the above. The author used a 2,000-volt transformer fed from alternating mains at frequency 50, and an adjustable liquid resistance in the secondary circuit. The electrodes were rods $3/16$ in. in diam., this size being necessary owing to the great heating effect. Several distinct spectra were obtained, depending on the conditions. If the electrodes are trued up in a lathe so that they are bright, the initial discharge is a pale glow round the electrodes. A pale green tint then begins to appear, showing the b triplet and the line 5528 but no hydride flutings, nor any lines of the two pairs mentioned above, while 4481 is very faint. The final aspect of the discharge is similar to that of the high-frequency one, though the spectrum and properties are different. The hydride flutings and the two pairs are absent, while the line 4481 is equal to 4571, and relatively much fainter than 4708 and 4852. It is evident from

this that dry hydrogen alone does not give the hydride spectrum. An interesting point arises over the line 4481, for although the high-frequency discharge shows much less heating power on the electrodes, yet this line is very much stronger than in the low-frequency discharge, so that the presence of this line cannot apparently be taken as a measure of temperature. The author is inclined to the view that the hydride spectrum is due to water vapour.

780. *Effect of Pressure upon Arc Spectra.* No. I., Iron. W. G. Duffield. (Roy. Soc., Phil. Trans. Ser. A. 208, pp. 111-162, March 26, 1908. Proc., Ser. A. 79, pp. 597-599, Sept. 27, 1907. Abstract. Chem. News, 96, pp. 158-154, Sept. 27, 1907.)—This paper is divided into two sections, the first of which describes the mounting and adjustment of the concave grating in the physics laboratory of the Manchester University. The second part contains the details and results of the experimental work. A direct-current arc between iron poles in air was used, and the pressure range was between 1 and 101 atmos. (absolute). The pressure vessel was a solid-drawn steel cylinder, 2 ft. long, 8 in. internal diam., and 1 in. thick in the walls, lined inside with 1/16 in. brass. The rods carrying the poles passed through stuffing boxes at the ends of the cylinder, and were fitted with a screw adjustment for feeding the arc. A glass window allowed the light of the arc to pass out, and the whole was surrounded with a water-jacket to keep the temperature low. Considerable difficulty was experienced in keeping the image of the arc upon the slit during the long exposure necessary, owing to the tendency of the arc to wander round the poles. This was overcome by a system of lenses and mirrors arranged as follows: One lens was fixed at its focal length from the slit and in a line with the grating and slit. Behind this lens was placed a silvered mirror at an angle of 45° with the horizontal, with its centre in a direct line with the slit and grating through the above-mentioned lens. A second silvered mirror, also at 45° with the horizontal, was placed 4 in. below the first mirror. The rays from the arc were directed as a parallel beam on to the second mirror by means of a second lens. The first mirror was rigidly fixed, while the second could be rotated or moved in a straight line to and from the arc. Any chance movement of the arc could be thus readily compensated. The first obvious effect of pressure upon the arc is the broadening of the lines, which is, moreover, different for different lines; it is unsymmetrical for most of the lines, being greater towards the red. There is also a definite displacement of the lines towards the red quite separate and distinct from the unsymmetrical broadening. The general effect of pressure is also to increase at first the number and intensity of the reversals, though this effect diminishes above 20 to 25 atmos. Two sets of photographs were taken (A and B) between the limits of $\lambda=4500$ and $\lambda=4000$, and each measurement of the displacement is a mean of a number of readings. The displacements are also given plotted against pressure, and from these curves it is evident that every line is displaced towards the red by an amount which increases with the pressure, the relation between displacement and pressure being, in general, linear. It is found, however, that the rates of increase of displacement with pressure vary very greatly for different lines. The lines fall mainly into three groups, whose average displacements for 1 atmo. excess pressure, assuming the linear law, are in the proportion of 1:2:4. Some irregularity occurs in the linear relation between 15 and 30 atmos., but there is some evidence that the abnormal displacements are connected with the great tendency of the lines to reverse at these pressures. Of all the lines

those of group III. are most susceptible to the disturbing cause, and the author finds that the lines of this group present two rates of increase of displacement with pressure—one for the lines when unreversed, and the other, very much lower, for the lines when reversed. The detailed study of the reversals obtained under pressure brought to light some interesting facts. Lines unreversed at 1 atmo. pressure either remain unreversed over the whole pressure-range or suffer reversal for a certain range of pressure and then return to their original condition with further increase of pressure. Lines originally reversed remain so up to the greatest pressure. Lines which reverse similarly are also displaced by equal amounts under pressure. Reversals show no tendency to undergo change of type with increase of pressure. In all cases of unsymmetrical reversal the absorbed part of the line is on the violet side of the emission line, and, further, in group III. it is not in general the most intense portion of the emitted light which is absorbed. Finally the enhancement and weakening of a few lines with pressure are noticed. Most lines preserve their relative brilliancy unaltered, but six are enhanced and six are weakened with increase of pressure. Considered as a whole the experiments afford overwhelming evidence of the existence of series of lines in the iron arc.

E. C. C. B.

781. *Magnetic Resolution of Spectrum Lines by means of the Method of Fabry and Perot.* P. Zeeman. (Konink. Akad. Wetensch. Amsterdam, Proc. 10 pp. 440-445, Jan. 28, 1908. Phys. Zeitschr. 9. pp. 209-212, April 1, 1908.)—The author has employed an étalon of the Fabry and Perot type for examining the magnetic resolution of the mercury lines in a weak field. The novelty consists in the application of interference fringes to this type of investigation, and the method has proved very successful. Details of measurements will be given in a later paper.

E. C. C. B.

782. *Röntgen Rays and Scattered Röntgen Rays.* C. G. Barkla. (Phil. Mag. 15. pp. 288-296, Feb., 1908.)—A note on the author's ether-pulse theory of Röntgen rays, and an account of experiments devised to disprove Bragg's "neutral pair" theory. According to the ether-pulse theory, when a primary pulse passes over an electron in a light atom, the electron is accelerated in a direction opposite to the direction of electric intensity in the pulse, as the electron is negatively charged. On the neutral-pair hypothesis it is supposed that a pair which strikes a substance consisting of light atoms is liable to be taken up only by an atom revolving in the same plane. It is sometimes ejected again, and its subsequent rotation and translation continue to take place in the one plane; therefore all pairs ejected in any direction at right angles to that of propagation of the primary rotate in the plane of primary and secondary propagations. A tertiary beam is therefore strongest when in the same plane. This is Bragg's explanation of the polarisation of the secondary beam as shown by the tertiary beams. The author's experiments, however, show that this cannot be the true explanation of the polarisation effect. The ratio of the intensities of secondary rays from carbon in two different directions was found to vary from about 1.85:1 with very soft rays to 1.45:1 for penetrating rays. The ratio never exceeded 2:1 in any experiment, while on the neutral-pair hypothesis the ratio should be roughly 7 or 8:1, and could not on any assumption be lower than 4:1. The results appear to afford strong confirmation of the electromagnetic pulse theory of Röntgen rays, and of the theories of scattering and polarisation based on this. The scattering of "soft" Röntgen rays by substances of low atomic weight has

been shown to be almost perfect, and the appearance of a radiation, which is very far from a purely scattered radiation when more penetrating rays are used, has been shown in a very marked way. The small proportion of scattered rays in other secondary radiations has been demonstrated. [See also Abstracts Nos. 1400 (1906) and 1826 (1907).] J. J. S.

783. *Magnetic Resolution of Spectral Lines and Magnetic Force. Part II. Asymmetry in Strong Fields.* P. Zeeman. (Konink. Akad. Wetensch. Amsterdam, Proc. 10, pp. 851-859, Dec. 24, 1907.)—An investigation into the magnetic resolution of the two yellow lines of Hg at $\lambda = 5770$ and 5791 . The former gives a perfectly symmetrical triplet, while the latter gives a triplet which is asymmetric. In magnetic fields of 15,000 to 80,000 gauss the asymmetry amounts to from 0.025 to 0.048 Å.U. The distance between the middle line and the component on the blue side is greater than the distance between the central line and the component on the red side; the difference between these two distances is defined as the asymmetry. E. C. C. B.

784. *The Unsymmetrical Resolution of the Yellow Mercury Line 5790 in the Magnetic Field.* P. Gmelin. (Phys. Zeitschr. 9, pp. 212-214, April 1, 1908. Phys. Inst., Tübingen, Feb. 22, 1907.)—A criticism of Zeeman's observation of the unsymmetrical resolution of the Hg line $\lambda = 5790$ [see preceding Abstract]. The author has observed the phenomenon with an echelon grating, and finds that the two outer components of the triplet are perfectly symmetrically situated as regards the original position of the unresolved line, and that the central line of the triplet does not occupy the same position as the original line. The change in position of the central line is proportional to the square of the field strength. E. C. C. B.

785. *Classification of Secondary Röntgen Radiators.* C. G. Barkla and C. A. Sadler. (Nature, 77, pp. 843-844, Feb. 18, 1908.)—Referring to the dependence of the character of the secondary on that of the primary Röntgen radiation, a brief account is given of a systematic study of the relation between the secondary and primary rays. It was found that substances could be conveniently divided into groups each consisting of elements which emit a radiation possessing many properties characteristic of that group. *H-S Group.*—The elements of this group when subject to very soft Röntgen radiation emit an almost perfectly scattered radiation of intensity proportional to the mass of radiating substance traversed by a beam of definite intensity. With a moderately penetrating primary the scattering becomes less perfect, and with a very penetrating primary beam there is considerable difference in character between the secondary and primary rays. *Cr-Zn Group.*—A striking characteristic of this group is the enormous ionisation produced by the secondary beams—of the order of 100 times that produced by an equal mass of one of the H-S group. This radiation, though produced by a heterogeneous primary, consists almost entirely of homogeneous rays of a very absorbable type. *Ag-I Group.*—This group is characterised by its sensitiveness to changes in the character of the primary rays when they are of ordinary penetrating power. Though for moderately penetrating primary beams the secondary rays are heterogeneous and do not differ in penetrating power very considerably from the primary, they do not exhibit the polarisation effect and are not distributed in the manner showing scattering as exhibited by rays

from the H-S group. *W-Bi Group*.—These substances, while they resemble the Cr-Zn group in the intensity and constancy in character of the rays emitted, have not yet been carefully examined. [J. J. S.

786. *Velocity of Röntgen Rays*. J. Franck and R. Pohl. (Deutsch. Phys. Gesell., Verh. 10. 5. pp. 117-186, March 15, 1908. Physikal. Inst. d. Univ., Berlin, Jan., 1908.)—The authors question the validity of the method used by Marx [Abstract No. 92 (1906)]. Marx excited the rays by means of waves along wires, and these waves also gave a varying potential to an insulated plate P on which the rays fell. According to Marx P emits electrons only when the rays reach it at the instant it is charged to a negative potential. The authors object that the potential to which P is raised by the waves is insufficient to alter by more than 10 per cent. the quantity of electrons emitted. Also the pressure of the gas surrounding P is so large that the Röntgen rays produce large numbers of ions in this space, and on account of the varying potential of the plate, these are sent in greater or less quantity into the Faraday collecting cylinder. The charge received by the cylinder depends therefore on two sources: the ions from the gas and the ions from P; by suitably altering the gas pressure it may be changed in sign. Himstedt has shown that at a certain distance from a discharging point subjected to an alternating potential the charge in the air is negative, while nearer to the point it becomes neutral and finally positive. The position of these zones depends on the potential and the gas pressure. Marx's results are really due to the Himstedt-effect. The varying potential on the Röntgen tube sets up oscillations on P, and Marx adjusts his bridge until his Faraday cylinder comes in the neutral Himstedt zone. The tube is then displaced, and the oscillations on P are thereby reduced in amplitude; the collecting cylinder is therefore no longer in the neutral zone. It is brought back to its former condition by altering the amplitude produced by the waves that have travelled along the wires. The null points have therefore nothing to do with the velocity of the rays; by altering their conditions the authors are able to obtain velocities varying between very wide limits. These criticisms are supported by a large number of experiments. R. S. W.

787. *Velocity of Röntgen Rays*. E. Marx. (Deutsch. Phys. Gesell., Verh. 10. 5. pp. 157-201, March 15, 1908. Physikal. Inst. d. Univ., Leipzig, Feb. 12, 1908.)—Marx's reply to Franck and Pohl. [See preceding Abstract.] His preliminary experiments show that the phase and not the potential of the oscillations at P decides the null point. This he shows by removing the wire carrying the wave to P, to the other terminal of the Röntgen tube; the discharge from P is altogether altered. He holds also that his results are independent of the gas pressure. In Franck and Pohl's repetition of his experiments the Himstedt-effect and oscillations at P due to the varying potential at the electrodes of the Röntgen tube probably come into play; this is because the potentials they used are much larger than those used by Marx. R. S. W.

788. *Diffraction of Röntgen Rays*. B. Walter and R. Pohl. (Ann. d. Physik, 25. 4. pp. 715-724, March 31, 1908.)—Haga and Wind's proof of the diffraction of Röntgen rays is questioned [Abstract No. 560 (1904)]. Owing to the long photographic development and the method of measuring the slit-image on the plate, certain contrast effects are introduced which produce an error in the measurements. The authors have repeated the experiments,

using a triangular slit; they find the width of the slit-image depends on the amount of energy sent through the slit, so that different times of exposure give rise to different images. It is concluded that the diffraction of the rays has not been established, and that the wave-length—if such exists—of Röntgen rays is well under 0.1μ .

789. Problems in Radio-activity. G. A. Blanc. (N. Cimento, 14. pp. 805-822, Oct., 1907.)—The discovery of temporary radio-activity in some substances has displaced the idea that radio-active substances served merely as transformers of energy coming from some extraneous source, and has led to that of a disaggregation of atoms into electrons and atoms of a new type of matter. Radio-activity is a property common to all matter, and its reactions differ from chemical reactions in their comparative independence of physical conditions and in the amount of energy liberated. Is radium a compound of other elements? If it were, much energy would be locked up in a compound containing inert helium, neon, argon, &c. May we not doubt the idea of a general disintegration of matter, considered as having "atoms" made up of groups of atoms?

Discussion of the corpuscles α .—On Rutherford's lines, everything radio-active should produce helium; but that is not the case. The genealogy of radio-active substances is considered, and the difficulties in accounting for atomic weights. Ancient lead should by this time have become non-active; how much Ag, how much He is there in it? Tests are being made in Rome. At Rome the thorium in the soil produces twenty times as much heat as that in the rocks examined by Strutt, and 600 times that calculated by Rutherford; this would imply, on Strutt's theory, a crust only 4 miles thick there. What are the effects of pressure on the radio-activity of deep-seated rocks? Can radio-active disintegration be promoted by change of physical conditions? This would be a great source of energy if it could be so: gold from lead (descending in atomic weight) would be a mere by-product of energy-liberation. High temperature promotes disaggregation; the Zeeman-effect shows that magnetism may do so; emission of electrons only differs from radio-activity in the small velocities acquired by these electrons, so that these cannot produce ionisation or photochemical effect, and a too slowly moving corpuscle would not acquire a positive charge by impact against a molecule; and in the electric discharge through rarefied gases we seem to have actual disaggregation, artificially induced.

790. Recent Advances in Radio-activity. E. Rutherford. (Nature, 77. pp. 422-426, March 5, 1908. Paper read before the Roy. Inst., Jan. 31, 1908.)—Gives a very clear account of recent work in this field, especially that part relating to the connection of the various active substances with each other. Boltwood has shown that the amount of actinium in minerals, like the amount of radium, is proportional to the amount of uranium. This indicates that Ac stands in a genetic relation to Ur. It does not appear probable that Ac belongs to the main line of descent of Ur, for the activity of Ac separated from a mineral, compared with Ra, is only about one-quarter of what would be expected under such conditions. It is possible that Ac is a branch descent from some member of the Ur family. At one stage of the disintegration two substances may be produced, one in greater and one in less amount. Ac may be this latter substance. A very clear, although condensed, account of Boltwood's determination of the period of decay of Ra is given. This gives about 2,000 years as the half-value period. Since e/m has been determined

for the α -rays, if e can be determined directly, m could be found, and so the nature of the α -particles would be fixed beyond doubt. An apparatus with this end in view, designed to count the number of α -particles ejected, as now being used by the author and Geiger, is described. The α -rays are shot through a narrow tube into a cylinder containing a central electrode. There they produce ions, and the pressure in the cylinder and voltage between the electrodes are so arranged that other ions are produced by collisions, so that the ionisation produced by the α -rays is magnified some thousands of times. The electrometer connected to one electrode gives a series of jerks corresponding to the entrance of an α -particle. In this way it is hoped to calculate the number of α -particles emitted in a given time. R. S. W.

791. *Counting of α -Particles with the Spinthariscopes.* E. Regener. (Deutsch. Phys. Gesell., Verh. 10. 8. pp. 78-88, Feb. 15, 1908. Physikal. Inst. d. Univ., Berlin.)—By making the polonium proportion small enough, it is possible to reduce the visible impacts of α -particles to 1 or 2 per sec. The author used a preparation mounted on a copper plate only 2 mm. in diam. It emitted altogether about 1,800 α -particles per sec., which agreed well with the value deduced from the saturation current. The author redetermined the value of the elementary charge e , and found 4×10^{-10} electrostatic units. He hopes to observe the charge of a single α -particle by means of the new string electrometer. E. E. F.

792. *Scattering of β -Rays by Matter.* J. A. Crowther. (Roy. Soc., Proc. Ser. A. 80. pp. 186-206, March 5, 1908.)—In measuring the absorption of β -rays they usually impinge over a wide solid angle on the absorbing layer; if they then enter the ionisation chamber, placed immediately behind, also over a wide angle, the method may correctly be said to measure the absorption, assuming that the ionisation produced is a measure of the energy of the rays. Schmidt has shown that the velocity of the rays is unaltered by passing through thin metal layers, so that the assumption is independent of any connection between velocity and ionising power. The beam of rays also loses energy by scattering, i.e., by the deflection of the β -rays from their rectilinear path, so that not all enter the ionisation vessel if the angle of entrance is small. The scattering is defined as follows: Let I_0 be the energy of a parallel beam of rays at a certain plane A; some distance away from this plane let an absorbing layer be introduced, and let I be the energy of the radiation parallel to the original beam crossing the A plane, then I/I_0 is the scattering. Uranium X is used as the source because it gives a homogeneous beam, and little absorption of the rays, and approximate parallelism is secured by passing the rays up a set of parallel brass tubes. At the end of these tubes the absorbing layer can be placed, and then above this is another similar set of tubes, followed immediately by the testing chamber. The ionisation in this chamber—measured by a tilted electroscope—is balanced by that produced in a similar chamber by a layer of uranium oxide, the exposed surface of which is varied. The spontaneous ionisation is thus eliminated. The results may be briefly summarised: Scattering is completed after the rays have traversed 0.015 cm. of Al and 0.0002 cm. of Au. The scattering, after correction for absorption, can be represented by $I/I_0 = e^{-\sigma d}$, where d is the thickness of the material traversed, and σ the coefficient of scattering. The ratio of σ to λ , the coefficient of absorption, is approximately constant and equal to 18 for all the substances examined. The value of the ratio σ/ρ , ρ is the density, shows variations similar to those for λ/ρ . The substances experimented upon are Al, Ag, Au, Cu, and mica. R. S. W.

703. Fatigue of Metals subjected to Radium Rays. J. A. Crowther. (Cambridge Phil. Soc., Proc. 14. pp. 840-850, March 10, 1908.)—The secondary radiations coming from two plates exposed to rays from radium are compared, then one of the plates is exposed continuously to radium for some weeks, and afterwards the secondary radiations from the two plates again compared. The long exposure to the rays, either β and γ only, or α , β , and γ , is found to have no influence on the secondary radiation produced, i.e., no fatigue is brought about. L. T. More has described some cases of fatigue in the secondary radiation due to Röntgen rays under the prolonged action of the rays [Abstract No. 1383 (1907)]. Prolonged exposure to radium is found to produce a similar fatigue in the secondary radiation due to Röntgen rays. Exposure to radium also greatly accelerates photo-electric fatigue. This fatigue can be removed by repolishing the exposed surface.

R. S. W.

704. Radium in Deep-sea Sediments. J. Joly. (Roy. Dublin Soc., Proc. 11. 26. pp. 288-294, March, 1908.)—In a recent paper [see Abstract No. 418 (1908)] the author described experiments which appear to show that the sea-water round the coast of Ireland possesses a richness in radium not hitherto suspected. This result has been extended by measurements made on samples of water collected between Madeira and England, and also on water from the Arabian Sea. In the present paper it is shown that the deep-lying sediments of the ocean are exceptionally rich in radium. The materials dealt with were partly from the *Challenger*, partly from the *Albatross* collections. Some globigerina ooze from off the west coast of Ireland was also treated. The results obtained are given below:—

Material.	Obtained.	Radium per Gm.
Blue mud	Off E. coast of N. America, 1,240 fathoms	3.1×10^{-12} gm.
Globigerina ooze	Off W. coast of Ireland, 570 fathoms	6.3×10^{-12} "
"	Middle of S. Atlantic, 1,990 fathoms	6.6×10^{-12} "
"	Pacific Ocean, W. of S. America, 1,825 fms.	7.4×10^{-12} "
"	Central Pacific, 2,042 fathoms	7.5×10^{-12} "
Red clay	N. Atlantic, off coast of Africa, 2,740 fathoms	13.0×10^{-12} "
"	"	28.0×10^{-12} "
"	"	gm. according to treatment.
"	Central Pacific, 2,350 fathoms	50.7×10^{-12} gm.
Radiolarian ooze	" " 2,760 fathoms	50.3×10^{-12} "
Manganese nodule	" " 2,370 fathoms	24.0×10^{-12} "

In the latter part of the paper the question of the source of the radio-active substances in mid-ocean sediments is discussed.

A. W.

705. Radium and the Earth's Heat. H. A. Wilson. (Nature, 77. p. 365, Feb. 20, 1908.)—It has been shown that the materials composing the surface of the earth contain on the average about 10^{-12} gm. of radium per gm., while about one-twentieth of this amount is sufficient to account for the heat lost by the interior of the earth by conduction. Strutt has suggested that the interior of the earth contains less radium per gm. than the surface. The writer of this note points out that if the amount of radium found by investigation is the same throughout the earth's mass, and supposing the specific heat of the earth is 0.1, and that 1 gm. of radium generates 100 cal. per hour, then the temperature of the earth's interior would rise by 10^{-4} degrees C. per

year if all the heat generated by radium were used up in raising the temperature. If the temperature of the interior rose 100°C . it is probable that the rise near the surface would be too small to be detected, so that even if the earth throughout contained 10^{-11} gm. of radium per gm., observations extending over 10,000,000 years would be necessary to detect the effect of the heat generated by the radium. R. J. Strutt (Ibid. pp. 865-866) agrees that the point referred to is worthy of serious attention. It may be supposed that the primary stock of radio-active material in the earth—uranium—has not been in existence for a longer time than is required for the attainment of thermal equilibrium by conduction, for the uranium is wasting away, and unless the supply is replenished it is clear that the gradient of temperature must diminish instead of increasing.

798. Penetrating Radiation. A. S. Eve. (Nature, 77, p. 486, March 28, 1908.)—The author takes exception to the conclusion of W. W. Strong that the penetrating radiation arises from radio-active material in the air [see Abstract No. 684 (1908)]. He states that "unless the earth's supply of active matter is augmented from without, or unless it arises in a manner at present unknown, the question may be negatived." From the amounts of radium in the ground and in the air the author calculates that the penetrating radiations due to radium C in the ground and due to the same substance in the air are in the ratio 15:1; also that in the case of thorium C the ratio is probably greater than this.

REFERENCES.

797. Photo-theodolite. C. Pulfrich. (Zeitschr. Instrumentenk. 28, pp. 72-77, March, 1908. Communication from the Optical Works of C. Zeiss.)—Describes, with illustrations, a photo-theodolite designed for use in pairs fixed, at the two ends of a ship, the same height above the water. In conjunction with the stereo-comparator the instruments can be used to determine the distance of objects more or less difficult to reach, the known distance between the two theodolites serving as base-line. For details see original paper.

798. Stereoscopic Effect. E. Grimsöhl, M. v. Rohr. (Phys. Zeitschr. 9, pp. 109-110, Feb. 1, and pp. 201-202, March 15, 1908.)—Gives a description of a stereoscopic effect observed when a 10-Pfennig piece is looked at through a lens about 9 cm. diam., and also discusses same. F. Grünbaum. (Deutsch. Phys. Gesell., Verh. 10. 5, pp. 234-241, March 15, 1908.)—In this paper a similar effect due to colour contrast, and observable with the naked eye, is dealt with.

799. Lumière's Autochrome Plates. A. Guébbard. (Comptes Rendus, 145, pp. 792-795, Nov. 11, 1907.)—It may be apprehended that after reversal the gradation on a scale of colours may not be identical with the gradation as impressed by exposure to the coloured object. A short exposure of the plate to white light filtered through the taking screen ought to bring about inversion as effectively as the processes prescribed for the purpose.

800. Screen Plate Colour Photography. J. H. Powrie. (Photographic Journ. 48, pp. 8-9; Discussion, pp. 9-10, Jan., 1908.)—A résumé of the history of the subject. Description of the Warner-Powrie plate; production, by development and fixing, of colour negatives from which colour positives can be printed. Printing for transparencies, for three-print methods, and on bleach-out paper are discussed. [See Abstract No. 45 (1908).]

801. Diffraction Gratings with Lines Circular and Straight. **A. Boutaric.** (Journ. de Physique, 7, pp. 284-291, April, 1908.)—A mathematical discussion of the diffraction phenomena presented by gratings with straight parallel but graduated lines and those with concentric circular graduated lines which are usually called zone plates. **E. H. B.**

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802. Fizeau's Speed-of-Light Experiment. **M. Cantor.** (Akad. Wiss. Wien, Sitz. Ber., 116. 21. pp. 1001-1012, June, 1907. Ann. d. Physik, 24. 3. pp. 439-449, Nov. 26, 1907.)—A discussion of the experiment, its possibilities in optics and acoustics, and as to whether the speed of propagation of waves or of wave-groups is really given. **E. H. B.**

803. Zone Errors of Telescope Objectives. **J. Hartmann.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 52. pp. 935-940, 1907.)—A modification of the Foucault method of knife-edge testing at the focus for the zone errors of the objective. **C. P. B.**

804. Some Phosphorescent Spectra. **H. Becquerel.** (Comptes Rendus, 146. pp. 440-446, March 2, 1908.)—A description of the spectra of certain minerals under different conditions. A detailed account is given of the bands as shown by chlorophane, a fluorite, an apatite under the influence of kathode rays, and by a sample of scheelite as observed in the phosphoroscope. **E. C. C. B.**

805. Magneto-optic Observations. **W. Voigt.** (Phys. Zeitschr. 9. pp. 120-124, Feb. 15, 1908.)—The first part of this paper discusses the phenomenon of transversal magnetic double-refraction observed in aromatic liquids by Cotton and Mouton [see Abstract No. 1503 (1907)]. The second part is occupied with a treatment, mainly mathematical, of the normal Zeeman triplets. **E. H. B.**

806. Photography of Infra-red; Dicyanin as a Sensitizer. **C. E. T. Mees and S. H. Wratten.** (Photographic Journ. 48. pp. 25-34; Discussion, pp. 34-37, Jan., 1908.)—Difficulties and methods discussed; diagrams of various infra-red spectra; pinacyanol and dicyanin compared. New filters passing only narrow monochromatic bands of the spectrum; their uses. **A. D.**

807. Colour Filters and Isochromatic Plates in Astronomical Photography. **R. J. Wallace.** (Astrophys. Journ. 27. pp. 106-124, March, 1908.)—A discussion of the adaptation of a colour screen to a photographic refracting telescope so that the best results shall be obtained with any given make of photographic plate as regards both definition and rapidity. Illustrations are given of the effect of suitable filters on star images taken with the 40-in. Yerkes refractor. **C. P. B.**

808. Investigation of Five Infra-red Metallic Spectra. **W. J. H. Moll.** (Archives Néerlandaises, 13. pp. 100-134, 1908. Slightly abbreviated from author's Thesis, Utrecht, 1907.)—The full paper, corresponding to Abstract No. 828 (1907).

809. Origin of Heat on Absorption of Röntgen Rays. **E. Angerer.** (Ann. d. Physik, 24. 2. pp. 370-380, Nov. 12, 1907. Physikal. Inst. d. Univ., Würzburg.)—Contrary to the conclusions of Bumstead [Abstract No. 800 (1906)] the heat evolved upon the impact of Röntgen rays, and due to the break-up of atoms with formation of β -rays, if there be any, is so small as to be negligible in comparison with the heat due to absorption proper. **A. D.**

810. Induced Radio-activity. **J. Danne.** (Comptes Rendus, 146. pp. 394-397, Feb. 24, 1908. Phys. Zeitschr. 9. pp. 306-307, May 1, 1908. Translation.)—Studies the curves of induced radio-activity obtained by Sarasin and Tommasina [see Abstract No. 2047 (1907)] in connection with the decay of activity of bodies subjected to radium emanation. The observed unipolarity of the decay curve may be explained by considerations of the distribution of the electric field in the apparatus employed. **E. E. F.**

HEAT.

811. Expansion of Platinum at Low Temperatures. H. Kamerlingh Onnes and J. Clay. (Konink. Akad. Wetensch. Amsterdam, Proc. 10, pp. 842-844, Dec. 24, 1907.)—There is a considerable difference between the expansion of platinum at low temperatures according to the formula of the authors previously given and that of Scheel, viz., 48μ for the expansion of a bar 1 m. long between -188° and $+16^\circ$ —a difference much greater than could be accounted for by the inaccuracy of the observations. A difference is found to exist when a bar of Pt is measured (1) a long time after having been reduced to a low and allowed to return to the ordinary temperature, and (2) measured soon after returning to the ordinary temperature from a low one. Taking the latter, the length immediately after cooling, the authors now give another formula—

$$l_t = l_0 \left(1 + \left\{ (a) \left(\frac{t}{100} \right) + (b) \left(\frac{t}{100} \right)^2 \right\} 10^{-6} \right),$$

and find for platinum (-188° to $+16^\circ$) that $(a) = 877.7$ and $(b) = 35.7$ in Onnes and Clay's formula, and $(a) = 861.5$ and $(b) = 37.0$ from Scheel's observations. Here the remaining difference, 84μ per m., is still large. The authors have also calculated a formula of the third degree for temperatures below 0° —

$$l_t = l_0 \left(1 + \left\{ (a') \frac{t}{100} + (b') \left(\frac{t}{100} \right)^2 + (c') \left(\frac{t}{100} \right)^3 \right\} 10^{-6} \right)$$

for the expansion of platinum between -188° and $+80^\circ$, using Benoit's observations from 0° to 80° , where (a') (b') (c') refer to the length at ordinary temperature immediately after cooling. The agreement between $(a') = 875.8$, $(b') = 81.6$, $(c') = -1.49$ (Benoit, Onnes and Clay); and $(a') = 874.9$, $(b') = 81.41$, $(c') = -0.94$ (Scheel), is fairly satisfactory. J. J. S.

812. Specific Heat of Iron-Carbon Alloys. P. Oberhoffer and A. Meuthen. (Metallurgie, 5, pp. 178-177, March 22, 1908. Communication from the Eisenhüttenmänn. Inst. d. Kgl. techn. Hochschule, Aachen.)—The specific heats of seven iron-carbon alloys, containing from 0.06 to 4.08 per cent. carbon, were determined in a slightly modified form of the apparatus used by Oberhoffer for ascertaining the specific heat of iron [Abstract No. 1541 (1907)]. The specimens were heated to 900°C. , and cooled slowly to ensure the complete separation of the carbon as carbide; metallographic examination showed that they consisted of mechanical mixtures of ferrite and cementite. In each case the average sp. heat between 650° and 0°C. was determined, and the results show that the relation between the sp. heats and carbon contents of iron-carbon alloys is represented graphically by a straight line, the sp. heat of iron being raised 0.0011 by each addition of 0.5 per cent. carbon. By extrapolation the sp. heat of pure iron is found to be 0.1482, and that of cementite 0.1581, the latter figure agreeing very closely with the theoretical value calculated by means of Kopp's law of molecular heat. F. C. A. H. L.

813. Latent Heat of Fusion of Pure Iron. C. Brisker. (Metallurgie, 5, pp. 188-184, March 22, 1908.)—Using Carpenter and Keeling's figures for the

solidification-points of iron-carbon alloys, the author calculates the latent heat of fusion of iron from the van't Hoff equations for the lowering of the freezing-point of a solvent. The value obtained, 81,6462 cal., is compared with the experimental values of various workers. F. C. A. H. L.

814. Velocity of Evaporation and Determination of Humidity. P. Vaillant. (Comptes Rendus, 146. pp. 582-585, March 16, 1908.)—At definite temperature and pressure the velocity of evaporation of water is proportional to the pressure-difference ($F - f$), where F is the max. vapour pressure at the air temperature and f the actual vapour pressure. Hence $Q = B(F - f)$, in which Q is the quantity of water evaporated in a given time, and B is a constant depending on the shape of the vessel, depth of liquid, &c. Experiments were carried out with different strengths of H_2SO_4 (the max. vapour pressures for which were known from Regnault's results), to show that the constant B was independent of the concentration. The following method was employed for the determination of the relative humidity: 5 c.cm. of solution was placed in a small flat-bottomed glass vessel, whose sides had previously been coated with a layer of paraffin wax, and the vessel was then counterpoised against a 50-gm. weight in a Collot balance furnished with a projection apparatus for reading the scale. The loss of weight which the solution underwent during 10 oscillations of the beam (109.25 sec.) was noted. If $\alpha_1, \beta_1, \alpha_2, \beta_2$ are the deflections right and left at the beginning and at the end of a measurement, then $p = k(\alpha_2 + \beta_1 - \alpha_1 - \beta_2)$, where p is the loss in weight and k a constant whose value was 0.0002. To avoid the determination of f , two identical vessels were used, one containing water and the other the solution. Three successive experiments were made: (i.) on the solution, (ii.) on the water, (iii.) on the solution. Each experiment lasted about 8 min. If p_1, p_2, p_3 are the corresponding values of p , then $\frac{p_1 + p_3}{2}$ is the weight of water which would be evaporated from the solution under the conditions of the second experiment. Hence—

$$p_2 = B(F - f) \dots (1), \quad 1/2(p_1 + p_3) = B(F' - f) \dots (2),$$

$$\text{and } p_2 - (p_1 + p_3)/2 = B(F - F') \dots (3).$$

The mean value obtained for B is 0.888, which corresponds to a value 0.61 per cm.² of surface per hour. But this constant depends on the shape of the vessel, &c. From equations (1) and (2) we obtain—

$$e = f/F = [2p_2 F'/F - (p_1 + p_3)]/[2p_2 - (p_1 + p_3)],$$

which gives the relative humidity. If pure H_2SO_4 is used for the solution, $e = -(p_1 + p_3)/[2p_2 - (p_1 + p_3)]$ and p_1, p_3 are, of course, negative. A. W.

815. Temperature of Gases in Vacuum Tubes. C. Féry. (Soc. Franç. Phys., Bull. No. 8. pp. 805-808, 1907.)—The Féry pyrometer can be employed to measure temperatures up to 2,400° C., beyond which the carbon filament of the glow-lamp lasts only a very short time. Another arrangement is described by which temperatures may be measured up to 3,600° C. The rays from an electric furnace kept at a known temperature are compared in a spectrophotometer with those from an arc lamp, which first pass through two thin prisms of smoked glass forming a plane-parallel plate of adjustable thickness. The apparent temperature of the arc is thus standardised in terms of the position of the double prism, and in measuring the temperature of a

gas the plates are adjusted to such a thickness that the spectrum lines of the gas have the same luminosity as the corresponding parts of the arc spectrum. When applied to the oxy-acetylene flame, the method gave $3,000^{\circ}\text{C}.$ (to 50°); and with a Cooper Hewitt lamp it was impossible to obtain a reversal of the luminosities, even when the double prism was removed, indicating that the mercury vapour is at a higher temperature than $3,600^{\circ}\text{C}.$ G. E. A.

816. *Instruments and Methods used in Radiometry.* W. W. Coblenz; (Bureau of Standards, Bull. 4, pp. 391-460, Jan., 1908.)—This paper deals with four instruments for measuring radiant energy, viz., the radio-micrometer, the linear thermopile, the radiometer, and the bolometer, with its auxiliary galvanometer. The radio-micrometer is capable of great improvement, by reducing its weight, by lengthening its period, and, by placing it in a vacuum [see Abstract No. 1589 (1907)]. On account of para- and dia-magnetism the sensitiveness of the radio-micrometer is very limited, being perhaps only a fifth of that of the best bolometers described. The Rubens thermopile was found to be as sensitive as the best bolometer, and its heat capacity can be greatly reduced by using thinner wires (of 0.06 to 0.08 mm. diam.), which can be made shorter, thus keeping the resistance low. The computed errors due to the Peltier-effect are about 1 part in 300. The thermopile is not so well adapted as is the bolometer for instantaneous registration of radiant energy, but on account of its greater steadiness it commends itself for measuring very weak sources of radiation, e.g., the extreme ultra-violet and infra-red region of the spectrum. By direct comparison it is shown that the radiometer can be made just as sensitive as the bolometer, but its period will be much longer. It was found that the radiometer is not selective in its action, and hence that it can be used for measuring ultra-violet radiation. The long period is the main objection to its use, but since it is easily shielded from temperature-changes and is not subject to magnetic perturbations this long period is of minor importance, so long as a constant source of radiation is dealt with. In spectrum energy work its usefulness is limited to the region in which the window is transparent to $20\ \mu$. The action of a radiometer is somewhat analogous to a photographic plate, in that it will detect weak radiation, provided time is allowed, and on account of its great steadiness is—of all the instruments considered—probably the best adapted to search for infra-red fluorescence. A bolometer installation is so distributed that it is difficult to shield from temperature changes. In spite of its small heat-capacity the bolometer has a "drift," due to a slow and unequal warming of the strips. Air currents which result from the hot bolometer strips also cause a variation in the deflections of the auxiliary galvanometer. Nevertheless, despite these defects, it is the quickest in action of the four instruments considered, and is the best adapted for registering the energy radiated from a rapidly changing source. For precision work it is necessary to keep the bolometer balanced to less than 1 cm. deflection. The auxiliary galvanometer is the main source of weakness in measuring radiant energy, and in places subject to great magnetic perturbations a period greater than 5 sec., single swing, is to be avoided. Hence, although a greater sensitiveness is possible, the working sensibility of the various galvanometers studied is of the order of $i = 2 \times 10^{-10}$ amp. per mm. deflection, at 1 m. Under these conditions the various bolometers used were (as a fair estimate of the recorded data) sensitive to a temperature-difference of 4×10^{-4} degree to 5×10^{-4} degree per mm. deflection, at 1 m. The galvanometer sensibility was found to be closely proportional to this period. The author also made a

direct comparison of the relative accuracy of the thermopile and the bolometer in measuring intense and weak sources of radiation, and the results show that there is little to choose between these two instruments. The manner of reducing the sensitiveness of the instruments is of importance in precision work. The use of a rotating sector disc for reducing the intensity of the source is liable to introduce errors which must be taken into account. The tests were made in a building isolated from mechanical and magnetic disturbances, and hence under the most favourable conditions. J. J. S.

817. *Saturated vapour Thermometers.* G. Marieni. (Elettricità, Milan, 30. pp. 82-84, Feb. 6, 1908.)—Gives an account of the various patterns and applications of G. B. Fournier's thermometers and pyrometers, which are based upon the fact that the tension of a saturated vapour is dependent upon its temperature only and not upon its volume. In practice, the bulb contains a liquid of low boiling-point in a layer over a liquid of much higher boiling-point. The latter transmits the vapour pressure to a considerable distance, if required, and it can readily be registered automatically, or work an alarm.

818. *The Thermodynamic Corrections of the Nitrogen Scale.* E. Buckingham. (Phil. Mag. 15. pp. 526-538, April, 1908.)—From certain theoretical considerations and assumptions the author concludes that there must be an equation of the form $M(p_c/r_c) \cdot \mu C_p = \phi(r/r_c)$, which is satisfied by the experimental values for all the gases. In this equation M is the molecular weight, p_c the critical pressure, r_c the critical temperature (in the absolute scale), μ the ratio of the cooling observed to the fall of pressure at the porous plug in the Joule-Thomson experiment, and C_p the specific heat at constant pressure. Taking the numerical data obtained by various experimenters and plotting the points, they were found to lie very closely on the curve—

$$M(p_c/r_c) \cdot \mu C_p = 53/(r' - 0.5) - 10.$$

Olszewski's inversion-point also lay on this curve. As this empirical equation has three constants, it can naturally be made to fit in with the observed results more closely than the equations given by Rose-Innes or D. Berthelot which contain only two constants. From this equation the thermodynamic corrections for the constant-pressure hydrogen thermometer are deduced. For hydrogen the results obtained agree only qualitatively with those obtained by Callendar and D. Berthelot. For nitrogen, however, the results obtained by physicists using very different methods of computation are in satisfactory agreement. A. R.

819. *General Laws for Vapour Pressures. II.* S. A. Moss. (Phys. Rev. 25. pp. 463-468, Dec., 1907.)—Forms equivalent to the author's expression, $1/T_s = c_1/T_s + k$, have been derived from Ramsay and Young's relation by Ayrton and Perry (Phil. Mag., series 5, 21, p. 259, 1886) and by J. D. Everett [Abstract 818 (1908)]. In the author's previous paper the expression given above was supposed to be equivalent to Ramsay and Young's relation. The latter may, however, be expressed mathematically in two quite different forms, one leading to the above symmetrical expression, and the other to a totally different unsymmetrical form, which is the one preferred by the authors of the original relation. In the present paper it is shown that the symmetrical form is to be preferred to the other, and that it represents

very nearly, if not exactly, a law of nature. A number of related points discussed in various isolated papers are also considered. [Compare Abstract No. 1209 (1908).] T. H. P.

820. *New Vapour-pressure Interpolation Formula.* E. Bose. (Phys. Zeitschr. 8, pp. 944-951, Dec. 15, 1907.)—The author finds that the formula, $\log p = A' + B'/T + C'/T^2 + D'/T^3$, gives more concordant results for the vapour pressure than that of Nernst, $\log p = A + BT + C \log T + D/T$, at least for the accurate representation of limited portions of the vapour-pressure curve, and for extrapolation towards the critical temperature. The experimental vapour pressures for ethyl alcohol, water, fluorobenzene, methyl acetate, ethyl formate, *n*-pentane, chlorine, and ethyl ether between -20° and 140° are compared with the values given by the above two formulæ. The mean relative deviations of the observed values from those calculated from the two formulæ are greatest in the case of alcohol, and are less for the author's expression than for that of Nernst, except for ethyl ether; indeed, leaving out alcohol and ether, the values given by the exponential formula differ from the observed numbers by less than the experimental errors. For water Thiesen's formula [see Abstract No. 806 (1899)] gives the best concordance. T. H. P.

821. *An Extension of Clausius' Theorem.* E. H. Amagat. (Comptes Rendus, 146, pp. 555-561, March 16, 1908.)—The validity of the reasoning which leads to the inequality of Clausius for the case of irreversible cycles has been questioned by several physicists. Certain authors state that the Clausius' integral is negative for an irreversible cycle. Duhem states that the integral is zero whether the cycle be reversible or not, provided that there are no passive resistances like friction or viscosity. Potier and Poincaré have demonstrated that the integral is zero or negative when the temperatures are those of the sources. The author first considers the case of a system having neither friction nor viscosity. In this case he proves that $\oint (dq/T) = 0$. Then taking friction and viscosity into account, he proves that—

$$\oint \frac{de}{T} = -A \oint \frac{dW_f + dW_v}{T},$$

where W_f denotes the work done against friction, and W_v the work done against viscosity. This agrees with Duhem's result. The theorem is extended to the case of an open transformation. A. R.

822. *The Relations between Potential-temperature and Entropy.* L. A. Bauer. (Meteorolog. Zeitschr. 25, pp. 79-82, Feb., 1908. Translation of a paper sent for the Bezold-Festschrift. Phys. Rev. 26, pp. 177-183, Feb., 1908.)—The term "potential-temperature" was introduced by v. Helmholtz to express the temperature of a gas when reduced to standard pressure adiabatically. v. Bezold deduced the theorem that strictly adiabatic processes in the atmosphere leave the potential-temperature unchanged. False adiabatic processes raise it according to the quantity of water evaporated. This, he says, is analogous to, but not identical with, Clausius' form of the second law of thermodynamics, that entropy tends always to a maximum. In the present paper are discussed the relations between potential-temperature so defined and entropy. If v denote volume, p , the standard pressure, and

θ the potential-temperature, θ is a function of p_0 and v . For a perfect gas, $\theta = (p_0/K)v$, K being the usual gas-constant ($= c_p - c_v$), c_p and c_v denoting the two specific heats. Hence it is shown that θ is for every gas proportional to the volume, and θ can be conveniently represented on the usual diagram, also θ can be calculated numerically by means of the adiabatic relation between T (the absolute temperature), v , and p . In effect, if "a" denote any state of the substance—

with $s = 1.41 = c_p/c_v$. The entropy is given by the equation—

$$\theta_a = T_a \left(\frac{p_a}{p} \right)^{\frac{s-1}{s}}, \quad s = \int \frac{dh}{T} = c_p \log T + K \log v + \text{constant},$$

whence is obtained $s = c_p \log \theta + \text{constant}$. It follows that the changes of θ and of s have the same sign. The writer then considers the modifications in the above results necessary if the gas be not perfect, showing that nature unaided invariably tends to increase the potential-temperature, as it does the entropy. Examples are given of this, viz., (1) the sudden expansion of a perfect gas without doing external work; (2) the case of heat conduction. The writer draws the conclusion that "the change in potential-temperature for a given change in absolute temperature, the volume remaining constant, decreases with absolute temperature."

S. H. B.

823. *Theory of Brownian Motion*. P. Langevin. (Comptes Rendus, 146. pp. 508-538, March 9, 1908.)—Einstein's value for the path described by a particle in Brownian motion may be calculated much more exactly by the method of Smoluchowski [see Abstract No. 1818 (1906)]. The formula obtained for Δ_x^2 , the mean square of the displacement Δ_x of a spherical particle after a time t , in a direction x is

$$\Delta_x^2 = \frac{RT}{N} \frac{1}{8\pi\mu a} t,$$

where a is the radius of the particle, μ the viscosity of the liquid, T the absolute temperature, and N the number of molecules in 1 gm.-mol. (8×10^{23}).

E. E. F.

REFERENCES.

824. *Radiation through Semi-permeable Plates*. F. Reiche. (Ann. d. Physik, 25. 3. pp. 521-568, March 3, 1908. Extract from Dissertation, Berlin.)—Deals with W. Wien's declaration (1894) that "we cannot change the energy of single colours in heat radiation." Wien's contention that "no plate can exist which perfectly transmits rays lying between two definite wave-lengths, and perfectly reflects all others, irrespective of direction, without infringing the second thermodynamic law," cannot be upheld.

E. E. F.

825. *Heat of Vapourisation*. C. Dieterici. (Ann. d. Physik, 25. 3. pp. 569-585, March 3, 1908.)—A mathematical discussion of the question of internal heat of vapourisation. For details the original paper must be consulted.

F. J. B.

826. *The Mixing of Gases*. W. McF. Orr. (Phil. Mag. 15. pp. 297-300, Feb. 1908.)—The author discusses the points raised in Burbury's recent papers [Abstracts Nos. 1544, 1867 (1907)].

A. R.

SOUND.

827. Noiseless Room for Sound Experiments. S. I. Franz. (Science, 26, pp. 878-881, Dec. 20, 1907.)—For many experiments in laboratories of physics, physiology, and psychology a place is needed from which all, or nearly all, external sound can be excluded. An absolutely noiseless room opens up numerous new possibilities of research. For this reason rooms have been constructed in many laboratories, but all the attempts to produce a noiseless room known to the author are more or less unsuccessful, with the exception of the room here described, which is in the Physiological Institute of the University of Utrecht, and was constructed under the direction of, and used by, H. Zwaardemaker. The room has no outside walls, and is 228 cm. by 220 cm. by 228 cm. The sides are of six layers as follows, beginning from the inside: (1) *Trichopse*, about 5 cm. thick. This is a felt-like material of horsehair, and covered with a net to keep the hair from falling. (2) Porous stone, 7.5 cm. thick. This part of the wall is isolated from the floor by a layer of sheet lead 8 mm. thick. (3) A dead air-space 2 or 3 cm. thick. (4) Wood partition 2.5 cm. thick. (5) A filling-in of ground cork and sand 4 cm. thick. (6) A special composition of ground cork (*Korkstein*) 8 cm. thick. Total thickness of walls, about 11 inches. The ceiling is similar. The floor is least satisfactory because an old one had to be used. To prevent vibrations passing from board to board the joints were sawed through, and the crevices thus made filled with lead. The whole floor was then covered with lead 8 mm. thick, and over this a very thick (1 cm.) carpet, sometimes two carpets. The double doors, window, and ventilation are also described. E. H. B.

828. Speed of Sound. M. Thiesen. (Ann. d. Physik, 25, 3, pp. 506-520, March 8, 1908. Communication from the Physikal.-Techn. Reichsanstalt.)—For several years the author has developed the method of closed resonators for determining the speed of sound. This it is hoped to apply to high pressures, various temperatures, and different gases. The present paper deals with dry air at 0° C. and free from CO₂, for which the value found is $(33,192 \pm 5)$ cm./sec. The resonator here used was a brass tube 100.004 cm. long at 0° C., 5.6 cm. inside diam., and 0.2 cm. thick in the wall, immersed in a box of ice. By an opening 0.1 cm. diam. at the centre of one end the sound from a siren is introduced into the resonator. Branch tubes to the ears enable the observer to recognise the instants of best resonance. Frequencies from 185 to 2,000 per sec. were used and determined by an electric chronograph. E. H. B.

829. Direction of Sound. T. J. Bowdler. (Phil. Mag. 15, pp. 318-332, March, 1908.)—Records a number of observations undertaken to throw light on the question of the perception of the direction of sound. Unequally long tubes are placed one to each of the observer's ears, and the direction of a sound judged and marked on a circle 28½ ft. in radius. Notes of wavelengths from 51 in. down to 4.4 in. were used. The author is inclined to think that in the case of the higher notes, perhaps in the case of all notes, the zone or arc in which the sound-images appear is settled by the relative intensity at the two ears, the actual position of the images within this zone

being produced by the maxima and minima within it produced by phase-difference at the ears. It is also concluded that in noting the direction of a fog-horn at sea the observer should be well away from any reflecting surfaces. (In one experiment an umbrella held to one side of the head at a distance of 2 ft. displaced the sound-image 20° .)

E. H. B.

830. Range of Certain Voices and Work of Speech. Marage. (Journ. de Physique, 7. pp. 298-304, April, 1908.)—A speaker is often uncertain in a strange room as to how he should speak in order to be audible to all present. The problem is sufficiently complex, depending on three chief factors: the room itself, the hearers, and the speaker. The influence of the room has been already dealt with [see Abstract No. 1087 (1906)]; one considers a hall good when it has no echo and the resonance is so short as to reinforce the sound producing it without trespassing upon the sounds following. Next, the ears of the audience are not equally sensitive to all sounds—low sounds are heard much less readily than high ones. There remains the influence of the speaker. It is commonly asserted that certain voices *carry* better than others. Is this true? and if so, what does it mean precisely? This question is here attacked quantitatively. For example, in a given hall, what energy must a speaker use in order to be heard according to whether his voice is bass, baritone, or tenor? The energy of the sound being given by the product VH of the volume V of air escaping from the lungs under the pressure H , it is necessary to determine these two quantities. But with an actual speaker this is difficult; the task is, however, simplified if for the actual speaker we substitute an artificial speaker, the vowel siren. Many experiments have convinced the author that the synthetic vowels OU, O, A emitted by the siren on the same note *fa*, common to the registers of bass, baritone, and tenor, produce the same impressions on the ear as these three voices. These three vowels were accordingly used in four halls, with the following results:—

Halls.	Energies in Kg.-m.		
	Bass (OU).	Baritone (O).	Tenor (A).
Trocadéro	0.0014	0.00012	0.000088
Eglise de la Sorbonne	0.00089	0.00012	0.000088
Académie de Médecine	0.00026	0.00009	0.000080
Amphithéâtre Richelieu	0.00015	0.000051	0.000021

This shows that in all the halls the bass is at a great disadvantage, having to put forth an energy from seven to sixteen times that of the tenor, the baritone being intermediate. If we notice the different halls, the tenor is seen to need four times the energy in the Trocadéro that he does in the Amphithéâtre Richelieu, the bass needing nine times as much in making the same change of halls. It is therefore concluded (1) that, for equality of hearing, certain voices carry better than others, that is, less effort is necessary; (2) that a speaker should develop V (volume) by increasing his lung capacity by appropriate exercise of the inspiratory muscles, and increase H (pressure) by like exercise of the expiratory muscles, and throughout avoid the escape of air uselessly without producing voice; (3) that in practice a speaker, in a strange hall should increase, little by little, the energy of his voice until he himself just perceives the resonance, and should then slightly diminish the energy, as this gives the

best result. In examining the work developed during speech, the author used his artificial larynx [see Abstract No. 98 (1908)] and a natural larynx, the latter both in ordinary conversation and in a large hall. The results were as follows:—

Quantities Measured.	Artificial Larynx.	Natural Larynx.	
		Ordinary Conversation.	Speech in a Large Hall.
Time of Inspiration	1 sec.	1 sec.	2 sec.
Time of Expiration	3 "	5 "	3 "
Volume of air expired ...	2.3 litres	0.5 litre	2 litres
V (volume)	2,070 litres per hour	300 litres per hour	1,440 litres per hour
H (pressure)	100 to 200 mm. of water	100 to 160 mm. of water	100 to 200 mm. of water
T (work)	207 to 414 kg.-m. per hour	30 to 48 kg.-m. per hour	144 to 288 kg.-m. per hour

E. H. B.

831. *Voice Vibrations Photographed.* Marage. (Comptes Rendus, 146, pp. 630-633, March 23, 1908.)—Any apparatus used to record the vibrations of the voice is apt to omit some components of the motion and introduce others. The present author has worked for some years on this subject, and now describes an improved arrangement for the purpose in which a photograph is automatically developed and fixed. The vibrations of the voice are taken up by a thin membrane of caoutchouc, which actuates a mirror and thus moves a beam of light reflected by it on to a sensitive paper. This paper is moved uniformly by an electric motor, and is passed through two baths to develop and fix the photograph. Specimen photographs are given in the paper of the vowel *a* sung to the note *mi*, and of the word *bonjour* spoken by a Frenchman. It is claimed that the process offers great advantages to teachers of singing and elocution by recording without bias the efforts, faults, and advances of their pupils.

E. H. B.

REFERENCES.

832. *Combination Tones.* L. Hermann. (Ann. d. Physik, 25. 4, pp. 697-714, March 31, 1908.)—A discussion of the mathematical and physical theories put forward by Helmholtz in the light of the recent work of E. Waetzmann [see Abstract No. 95 (1908)], the various points of interest being treated at length and special cases detailed.

E. H. B.

833. *Compound Singing Flames.* G. Athanasiadis. (Comptes Rendus, 146, pp. 533-534, March 9, 1908.)—Describes a singing flame which simultaneously responds to two tones, one proper to that of the jet and one depending on the tube used to enclose it.

E. H. B.

834. *Frequency of High Notes.* P. Debye. (Ann. d. Physik, 25. 4, pp. 819-823, March 31, 1908.)—This is a short note on the recent paper by F. A. Schulze dealing with the determination of the frequency of notes so high as to be just below or above audibility [see Abstract No. 645 (1908)]. The present author points out that by superposing the forced and free vibrations of the plates in question the nodal figures observed may be derived, at any rate qualitatively.

E. H. B.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

1836. *Electromagnetic Mass*. T. Levi-Civita. (N. Cimento, 14, pp. 271-304, Oct., 1907.) Paper read before the Soc. Italiana di Fisica, Parma, Sept., 1907.)—Coulomb's law suffices for the force on a point-charge of electricity in an electrostatic field, Biot and Savart's for the force on an element of current in an electromagnetic field. Superpose the electrostatic and the electromagnetic field; then a point-charge is acted upon only by the electrostatic force if it be stationary, by this and an electromagnetic force if it be in movement, which latter force is proportional to the velocity of the movement of the charge and varies with variations in the electromagnetic field. Any resultant force on a point-charge is equivalent, instantaneously, to the resultant of the superposition of an electrostatic and an electromagnetic field (Lorentz's law). Within certain limits, point-charges may be summed or integrated so as to represent volume-charges. The electromagnetic field may be considered as made up of (1) any external electromagnetic field, and (2) the auto-field, produced by the charge itself, through its movement. The former component may be fairly constant throughout the volume of the volume-charge; the latter cannot. For this reason we cannot treat it by reducing the charge to material points, as in mechanics; it is, more as if we had to begin the study of mechanics by studying deformations. A charge de , associated with mass dm , within volume dS , is acted upon by a force $f + \phi + \psi$, where f is due to the external electromagnetic field, ϕ to the auto-field, and ψ to all other causes (gravity, molecular actions, &c.); and this is equal to $dm \cdot a$, where a is the acceleration. Throughout S , we have $ma = F + \phi + \psi$. If the charge do not move, $\phi = 0$; but if it do, the elements of this, ϕ , do not in general follow the principle of equality of action and reaction, since the propagation from one element to another takes a certain amount of time; but if the velocity be small (e.g., in rarefied gases), we may make $\phi = 0$ and $\psi = 0$; whence $ma = F$. This reduces, if e be the charge, E the electric force, c the velocity of light, H the magnetic force, v the velocity of movement, all at the barcentre of the volume distribution within volume S , to $ma = e[E + (1/c)(H \cdot v)]$. *Kathode Rays*.—Take these as consisting of electrified particles projected from the kathode; the equation $ma = F$ applies and explains the normally straight path and, if e be negative, explains the deviations in an electrostatic or an electromagnetic field (at right angles to the axis of the tube) or a superposition of these. Whence e/m is found; also the mean velocity $= c/8$ to $c/10$. In electrolysis $\eta = e/m$; γ is the electro-chemical equivalent; $\eta/\gamma = 1/\gamma$. In kathode rays $e/m = 1800\gamma$. This difference in the value of e/m in the two cases raises the question whether in kathode rays ponderable matter has anything to do with the result. Other radiations—e.g., from charged metallic surfaces exposed to ultra-violet rays, or from carbon filaments incandescent in hydrogen—give e/m a value like that in kathode rays, 1800 γ . The assumption that $\phi = 0$ is therefore unsatisfactory, and we have to study the influence of the auto-field. ϕ is the resultant of the mutual action of elements of the moving charge, and, taking

time of propagation into account, depends on the state of motion of these at preceding instants as well as at the current instant of time, which is unmanageable. As to artifices of solution: (1) The principle of reaction leads to $\phi = 0$; (2) assume the moving charge to have a material solid nucleus on which its distribution does not vary. This becomes like a problem of mass-movement, except that the forces depend upon the previous history. The result is expressible in functions of six parameters, three determining the position in space, three the orientation. Six equations are required. For simplification, Abraham (Theorie d. Elektrizität, Chap. III., 1906), through a provisional assumption that acceleration $= 0$, reaches a form similar to that of a problem of solid dynamics in which the forces depend on the acceleration as well as the position and the velocity, something like the case of a solid in a perfect liquid, and apparently loaded by it. Working this out, Abraham arrives at a longitudinal mass, m' , and a transversal mass m'' , both of which depend on the velocity as well as on the material mass m , the charge e , and the radius R of the particle. J. J. Thomson studied a particular case of this (Phil. Mag. 5, p. 11, 1881). For small velocities, m' and m'' become both equal to $m + m_0$, where m_0 is a virtual additional inertia due to the auto-field, and $a = F/(m + m_0)$. For velocities up to one-third the velocity of light the error does not exceed 5 per cent. Then $e/(m + m_0) = 1800\eta$, while $e/m = \eta$; from which m in the expression $(m + m_0)$ must be, say, zero, and the conclusion is that in cathode rays there is no transport of matter, but only of negative electric charges. Then each of these charges is 8×10^{-30} c.g.s. electrostatic units of electric quantity, the same as the charge on an electrolytic ion; but the diam. thereof is about 10^{-13} cm. as against 10^{-8} cm. for the diam. of an electrolytic ion. This small size would account for the penetrating character of cathode rays. In positively charged radiations—Goldstein canal-rays, heated positively charged wires, α -rays from radio-active bodies— $e/(m + m_0) = \frac{1}{2}\eta$ to η , according to the nature of the electrodes and of the gas in the tube; which tends to show that the material mass m does take part in the discharge along with the virtual mass m_0 , due to the positive charge conveyed. The various theories of the mechanism of electrons, Abraham's (loc. cit.), Lorentz's (Abstract No. 1491 (1904)), Bucherer (Math. Einführ. in d. Electronentheorie, Leipzig, 1904), Langevin, and Poincaré are considered; none are completely satisfying, and Larmor's is itself an approximation only. J. J. Thomson's conception of the structure of the atom fails to explain and is inconsistent with the additive property of matter: $m_0 = ke^2/c^2R$; whence a cubical group of 18 cubical sub-atoms would have a 82-fold instead of an 8-fold mass. Supplementary hypotheses might get over this difficulty, but at present only conjecturally. The electromagnetic theory, as at present constituted, even though it start from independent electromagnetic postulates, calls in at some point the mechanical principle $F = ma$, and thus argues in a circle. The future may amend this.

536. General Electrodynámic Theory. W. Ritz. (Annal. Chim. Phys. 13, pp. 145-276, Feb., 1908).—In view of the probable absorption of mechanics in the science of electrodynamics the author proposes to subject the fundamental electromagnetic conceptions to a rigid criticism, in order to prepare them for that definiteness of statement which has already been attained by pure mechanics. The criticism touches seven different points, which may be summarised as follows: (1) Electric and magnetic "force" may be entirely eliminated, space and time relations alone being left. (2) Modern

theory admits of an infinite number of solutions, mostly opposed to fact; retarded potentials must be introduced and elementary actions at a distance reverted to. (8) The localisation of energy in the ether is indeterminate and admits several simple solutions. (4) The gravitational problem is entirely unsolved by electromagnetic theory. (5) Action and reaction are not equal in modern theory. (6) Kaufmann's results do not prove that the mass of electrons is purely electromagnetic, since the forces might be linear functions of the speed. (7) Modern theory is driven to abrogate the parallelogram of velocities and to regard time and simultaneous occurrence as relative terms. Instead of shaking the foundations of kinematics the author prefers to abandon the hypothesis of the ether, and with it the representation of the phenomena by partial differential equations. Even as it is, the necessity of explaining the free motion of bodies through the ether and the absence of any influence upon it has reduced Fresnel's mechanical ether to a simple physical space, or a system of absolute co-ordinates. It is now only a mathematical abstraction, and its suppression would only be the last phase of a long evolution. As it stands it involves an irreversibility, implied by the loss of energy radiated into space, and this is not included in the partial differential equations. It is more logical to suppose that the ether does not exist, and to give up thinking in terms of that image. The propagation of light is a relative motion, like all other motions, and only relative velocities play any part in nature. The notions of electric and magnetic fields, in so far as they introduce absolute motion, must also be abandoned. We have no means of proving either the existence or the motion of the ether. All we can prove is the finite rate of emission of some periodic influence, and this we can only do by means of ponderable matter. The author proposes to put in place of the undulatory ether theory a conception borrowed from the emanation theory of light. Every electrified body emits in all directions infinitely small particles with a velocity which, relative to the body, is the velocity of light. It follows that in whatever way the body may move, all particles emitted at a given instant are contained (at any subsequent instant) in the surface of a sphere whose centre is the same body. Successive "wave-surfaces" are always concentric, and not eccentric, as are wave-surfaces emitted by a moving body on the wave-theory. The author's principle is really the principle of relativity, which leads to the same result. The minute particles are only postulated provisionally in order to give an imaginable picture of a finite rate of propagation of electrical influence. Electric action on any other body is then entirely governed by the number, speed, and direction of the particles traversing it. The author carries out this conception, in detail in the various branches of electromagnetic theory, and shows that all observed parts are covered by it. Optics are accounted for somewhat less simply and elegantly than in Lorentz's theory, but, on the other hand, all difficulties presented by aberration and Fizeau's experiment disappear. Gravitation is propagated with the velocity of light, and the secular anomaly in the orbit of Mercury is accounted for.

E. E. F.

837: *Principle of Relativity*. A. H. Bucherer. (Phil. Mag. 15, pp. 816-818, March, 1908.)—Replies to Cunningham's objections [Abstract No. 2075 (1907)] to his formulation of the principle of relativity. Bucherer's is the only electromagnetic theory which gives the forces experienced by a moving electron in a condenser field and in the field of an electromagnet. The method is purely phenomenological, and attempts no physical interpretation. The Lorentz deformation excludes a purely electromagnetic basis of

mechanics. The work of the external electric forces acting on the electron does not have its exact equivalent in the increase of the electromagnetic energy of the electron. Therefore a certain inner energy of non-electromagnetic character must be ascribed to the electron. The same conclusion must be drawn from Cunningham's calculations if properly interpreted. The author concludes by pointing out that "Cunningham says the Lorentz-Einstein theory is the only theory that can account for certain optical phenomena. In fact, he asserts that it is required 'to explain how a light-wave travelling outwards in all directions with velocity C relative to an observer A may at the same time be travelling outwards in all directions with the same velocity relative to an observer B moving relative to A with velocity v .' Cunningham then proceeds to show that this requirement is satisfied by the Lorentz-Einstein transformation." The author states that he is not aware that such a "requirement" is necessary to explain any known fact of observation.

E. E. F.

838. *A Criticism of the Ordinary Method of Stating Faraday's Law of Electromagnetic Induction.* C. Hering. (Amer. Inst. Elect. Engin., Proc. 27. pp. 339-349, March, 1908; also Electrical World, 51. pp. 558-560, March 14, 1908. Electrician, 60. pp. 946-948, April 8, 1908. Abstract.)—The fundamental law of electromagnetic induction is stated in two different ways. Faraday's statement is that when a conductor cuts magnetic lines of force an e.m.f. is generated. Mathematical electricians generally state the law as follows: The induced e.m.f. in a circuit equals the rate at which the flux embraced by the circuit is altering. It is known that it is exceedingly difficult to give a rigorous proof of this law in the general case, and so mathematicians usually accept it as an experimental result or prove it for particular cases. The author points out a case where this law might mislead. Consider a simple conducting circuit with clip ends pressed together embracing one limb of a horseshoe magnet. By means of the clip ends this circuit can be unlinked from the limb without breaking the conducting circuit. The lines of force linked with it are enormously reduced, and yet experiment shows that no appreciable e.m.f. is developed. The circuit can be put over the pole of the magnet and unlinked by the clips many times a second, a uni-directional current thus being induced in it. A direct-current generator without a commutator can be easily constructed in this way. The author concludes that no e.m.f. is generated unless the wire actually cuts the lines of induction. He considers that Faraday's version of the law of induction is simpler, more universal, safer, more direct, and much easier for students to learn and comprehend than Maxwell's.

A. R.

839. *The Constituents of Atmospheric Radio-activity.* H. M. Dadourian. (Amer. Journ. Sci. 25. pp. 335-342, April, 1908.)—The activity of a negatively charged body in open or underground air is due to radium A , B and C , and thorium A , B and C , each of which accumulates and decays at a perfectly definite rate, so that only after 8 days' exposure, when the ionisations produced by these six disintegration products attain 0.99 of their equilibrium values, can the amounts of these present on a body at any instant be taken as proportional to the quantities of each in unit volume of air. In the open air at New Haven the initial ionisation produced by thorium products was found to be from 25 to 40 per cent. of that due to radium products, the amount of Ra emanation being from 80,000 to 50,000 times that of the Th emanation,

whereas at Rome, calculating from data given by Blanc [Abstracts Nos. 888 and 2049 (1907)], the amount of Ra emanation is only 20,000 to 80,000 times that of the Th emanation, W. H. S.

DISCHARGE AND OSCILLATIONS.

840. *Photo-electric Fatigue*. H. Dember. (Phys. Zeitschr. 9, pp. 188-190, March 15, 1908. Physikal. Inst. d. techn. Hochschule, Dresden, Jan., 1908.)—Photo-electric fatigue has been attributed to the formation of ozone. Sodium or sodium potassium alloy in an atmosphere of hydrogen is here investigated. Fatigue is shown even when not exposed to light, but this may be due to absorption of the gas. Another way in which the fatigue may apparently be shown is pointed out. There exists, according to Stoletow and Thomson, a critical pressure for which the current is a maximum; if gas is absorbed the current would be altered on account of the change in the gas pressure. It might be possible so to choose the initial gas pressure that the current over long periods is constant. R. S. W.

841. *Ionisation of Gases by Ultra-violet Light, and the Structure of Light*. J. J. Thomson. (Cambridge Phil. Soc., Proc. 14, pp. 417-424, March 10, 1908.)—The source of light is a vacuum tube with a Wehnelt cathode. This can be moved past a quartz window, on the other side of which a stream of air, CO, or NH₃ is forced. After passing the quartz window the gas traverses the annular space between two concentric cylinders, where it is tested for ionisation by a tilted electroscope. It is found, in agreement with Lenard's results, that ions are produced. In air the leak is increased 8 times the natural leak, in CO, 16 times, in NH₃, 150 times. The light which produces these ions comes most copiously from the anode; it is absorbed by 3 mm. of air at atmospheric pressure, and still more rapidly by coal-gas. The author supposes that the radiations which produce ionisation possess a structure; it is further supposed that the ether has disseminated through it discrete lines of electric force in a state of tension, and that light-waves and Röntgen rays consist of transverse vibrations and pulses respectively travelling along these lines. If the lines are relatively far apart it would explain the fewness of the molecules ionised even by the most intense radiations. It would explain also the fact that the number of corpuscles emitted by a plate exposed to ultra-violet light increases as the intensity of the light increases, while the velocity of the corpuscles remains constant; for the increased intensity of the light means a greater density of the lines while the energy in each remains the same. The fact that the velocity of the emitted corpuscles varies continuously with the frequency of the light makes it very unlikely that this emission is a resonance effect. According to the view here developed the energy in the lines increases with the frequency. The units in the γ -rays will be widely separated since the energy per unit is probably 10,000 times that in ultra-violet light. As these units possess momentum as well as energy they will have all the properties of material particles except that they cannot move at any other speed than that of light. R. S. W.

842. *Behaviour of Emanation Particles in an Electric Field*. H. W. Schmidt. (Phys. Zeitschr. 9, pp. 184-187, March 15, 1908. Physikal. Inst. d. Univ., Giessen, Feb., 1908.)—The saturation current in a cylindrical vessel

is measured, and simultaneously the amount of active matter deposited from emanation on the negative central electrode. This is repeated for different voltages. The curves: volts-saturation current and volts-active matter are nearly the same shape, whence it is concluded that so far as velocity and recombination are concerned the particles forming the active matter behave as ions. Hence to obtain the greatest amount of activity on an electrode placed in emanation, the size of the vessel and the voltage applied must be such as to obtain the saturation current. R. S. W.

843. *Slow Kathode Rays.* O. v. Baeyer. (Deutsch. Phys. Gesell., Verh. 10. 4. pp. 98-114, Feb. 29, 1908, Physikal. Inst. d. Univ., Berlin.)—There is but little agreement in the results obtained for the specific charge of the electrons from measurements on slow kathode rays, in contradistinction to the determinations made for rays of greater velocity. The author has set before himself the following points especially: (1) The establishment of a slow kathode radiation of the greatest possible homogeneity and of great intensity by means of glowing oxide cathodes; details of the arrangements are given in the paper. (2) The ionisation capacity of slow kathode rays. Observations were made with an apparatus similar to that used by Lenard in his experiments on the ionisation due to electrons produced by photo-electric action. The glowing wire was surrounded by a coaxial cylinder formed of brass wire gauze of a diam. of 1 cm. And this again was surrounded by a second cylinder of brass of 2 cm. diam. Between the wire and wire-gauze a variable p.d. V_1 was kept up, and thus kathode rays of various velocities were produced. These penetrating through the gauze did not reach the second cylinder, for the latter was at the negative potential ($V_2 = 20$ volts) opposite to the wire gauze, which exceeded the potential of the hot wire. When ionisation of the volume of gas between cylinder and gauze sets in, a positive charge must be conveyed from gauze to cylinder. If the ionisation is proportional to the electrons passing across, this current must be observable by a galvanometer placed between the cylinder and the gauze. From $V_1 = 0$ to $V_1 = 10$ no current between the outer cylinder and the gauze could be observed. Beyond the value $V_1 = 10$ volts, however, a positive current from cylinder to gauze set in which quickly increased as V_1 rose in value. The observed values are as follows:—

V_1	i_-	i_+	i_+/i_- = No. of +-ions.
14	20,000	16	0.0008
13	18,000	7	0.0004
12	18,000	4	0.0008
11	9,000	8	0.0008

Here V_1 is the p.d. between hot wire and the wire-gauze, i_- = amount of the electrons going from the wire-gauze to the outer cylinder (measured by the magnitude of the current with $V_2 = 0$), i_+ = amount of + ions formed between wire-gauze and cylinder (measured by the current with $V_1 = 20$), i_+/i_- = number of the ions formed per electron. (3) The velocity of the kathode rays produced was investigated. With lowering of the negative potential of the cylinder the amount of the electrons rose. A small part of the total radiation went out at right angles to the wire-gauze with the velocity V_1 . (4) The secondary radiation as regards reflection was investigated. In the circumstances of the experiment the portion of the rays

reaching the reflector was found to be approximately constant. This shows that no marked scattering of the rays takes place in a gas at rest. The reflector was found to be the point of origin of a radiation. The means of avoiding the reflection were next considered. The researches described have shown the presence of a phenomenon resembling reflection with slow cathode rays. Further observations are required to determine how this reflection depends on material, on angle of incidence, and, above all, on the primary velocity of the rays. The determination of the velocity and specific charge of slow cathode rays may be improved through the observations described.

844. Generation of Luminous Glow in an Exhausted Bulb Moving in an Electrostatic Field. F. J. Jervis-Smith. (Roy. Soc., Proc. Ser. A. 80, pp. 212-217, March 5, 1908.)—If an exhausted bulb is rotated round a horizontal axis above a disc of sulphur, which has previously been rubbed, it becomes filled with a glow. If the electrostatic field is produced by means of charged plates a similar effect is found. If the sulphur disc is rotated and the bulb kept at rest no such effect is noticed. Bulbs exhausted to the same degree of vacuum as a Röntgen-ray bulb give the best effects. The current producing the glow is unidirectional, and is acted upon by a magnetic field.

845. Anode Rays. E. Gehrcke and O. Reichenheim. (Deutsch. Phys. Gesell., Verh. 10. 5. pp. 217-225, March 15, 1908. Communication from the Physikal.-Techn. Reichsanstalt.)—A continuation of earlier work [Abstracts Nos. 1180 (1907) and 106 (1908); also Ann. d. Physik, 25. 5. pp. 881-884 (1908)]. A discharge tube is formed of two bulbs joined by a fairly narrow horizontal tube. Each bulb contains an electrode; the tube projects into each bulb. When a discharge is sent through there appears a set of striation cathode rays as usual, but no anode rays. When iodine vapour is admitted anode rays also appear and cause the usual phosphorescence on the glass. Bromine and chlorine vapour give similar results. The best results are obtained with iodine vapour in hydrogen gas. The rays cannot be obtained in nitrogen, nor with an induction coil; the source of current in these experiments is a Wimshurst machine. The rays appear to originate from a point just inside the connecting tube and at the end near the cathode. The potential gradient in the tube is considerable near this point, but much smaller along the remainder of the length.

846. Spectrum of the Singing Arc. M. La Rosa. (Accad. Lincei, Atti, 17, pp. 200-201, Feb. 18, 1908.)—To obtain a singing arc it is not necessary to have a circuit in resonance with the arc circuit [see Abstract No. 697 (1907)]; it suffices to shunt a considerable inductionless capacity across the terminals of the arc. This species of singing arc, however, shows notable differences from Duddell's arc. The carbons acquire none of the distinguishing positive and negative shapes, and the spectrum is essentially different. Under pure conditions, the spectrum is the simple line-spectrum of the high-pressure spark, and consists of nitrogen, oxygen, and carbon lines. These gradually disappear on reducing the capacity in the shunt, or quickly on introducing a small inductance in it, and the ordinary band spectrum of the carbon arc, as seen in the continuous arc or Duddell's arc, then reappears. The study of the electrical mechanism of the new species of singing arc is reserved for a future publication.

E. E. F.

847. Unipolar Phenomena in Tesla Transformer. W. Winter. (Phys. Zeitschr. 8, pp. 890-896, Nov. 1, 1907.)—Himstedt's phenomena (Wied. Ann. 52, p. 487, 1894; and Abstract No. 1708 (1899) at a point on a Tesla secondary pole are also observed when an antenna is used; and with an antenna the effect is reversible, i.e., if an antenna positively charge an exploring sound brought near it and negatively charge one at a greater distance, earthing the other secondary pole reverses these effects. The antenna gives out four kinds of radiation, which produce the effect of four co-existing, coaxial, cylindrical fields round the antenna, alternately opposite in electrical character; and of these four the two outer show a fall of potential towards a null-point. The inner two fields are also reversed by earthing the other pole of the secondary. The phenomena are explained by rapid alternations of the radiations from the antenna and the corresponding velocities of the ions. A. D.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

848. Thermo-electricity. M. Cantone. (Accad. Lincei, Atti, 17, pp. 187-194, Feb. 16, 1908.)—A study of Kirchhoff's law of multiple circuits as regards thermo-electric effects. The density of free electrons is nearly the same in all metals, but there are comparatively very few electrons per cm.³ in Fe and Sb and very many in Co and Bi, and also in Ni at temperatures far removed from 850°C. E. E. F.

849. Resistance Thermometers. E. König. (Schweiz. Elektrot. Zeit. 5, pp. 188-184, March 21; 145-146, March 28, and pp. 157-158, April 4, 1908.)—Two platinum thermometers of the usual construction were compared with a Tonnelot thermometer in a petroleum bath and in an air bath, and tables are given showing the rapidity with which the resistance thermometers assumed the temperature of a bath. The range of temperature was small. The indicator was a differential galvanometer, one coil of which was in circuit with a constant resistance, and the other was in circuit with a platinum thermometer. The two circuits were connected in parallel to the source of current, and the coils tended to rotate in opposite directions when a current flowed through them. The coils were firmly connected to each other and to a central axis, and there was no directive force on the coils except when a current was flowing. On the circuit being made the coils took up a position where the total torque was zero; a change in position indicated a change in the ratio of the currents, and hence a change in the resistance of the platinum thermometer. The change in position of the coils depends on the distribution of the magnetic lines of the field in which they are placed, but in practice it is possible to get very nearly equal angular changes in position for equal increments of temperature. F. E. S.

850. Electrical Resistance of Gold, Silver, Mercury, Bismuth, and Lead at very low Temperatures. H. Kamerlingh Onnes and J. Clay. (Konink. Akad. Wetensch. Amsterdam, Proc. 10, pp. 207-215, Oct. 31, 1907. Communication No. 99c from the Phys. Lab., Leiden.)—Using wires of Ag, Au which are considered to have been purer than those employed by Dewar, of Bi less pure, and strip lead, the authors have determined the changes of resistance at the lowest attainable temperatures, using liquid hydrogen (solid hydrogen evaporating at 2.5 mm. pressure). The point of proportionality ($dr/dT = r/T$) is found to be situated so low that two hydrogen temperatures

are insufficient for determining this point by the aid of the point of inflection ($d^2r/dT^2=0$). Matthiessen's theorem, confirmed by Fleming down to -200°C ., does not hold for hydrogen temperatures. The resistances found are all expressed with respect to that at 0° as unity. *Gold*.—The percentage of impurity is given in brackets in the heading; thus, Au_{IV} and Au_{V} are by far the most pure.

Temperature.	Au_{III} (0.015)	Au_{IV} (0.005)	Au_{V} (0.005)	Au_{VI} (0.005)	Au_{VII} (0.008)	Au_{VIII} (0.04)
0°	1	1	1	1	1	1
-108.88	0.59601	0.59889	0.59806	0.64927	0.60545	0.64549
-188.00	0.27658	0.27177	0.27098	0.87058	0.80070	0.87099
-197.87	0.21456	0.20968	0.20871	0.81659	0.28908	—
-205.01	—	—	0.17897	—	0.20992	—
-215.84	0.14058	0.18407	0.18387	0.16822	0.16681	—
-252.98	0.01802	0.008743	0.008108	0.13669	0.04554	0.18942
-255.18	—	—	0.005691	—	—	—
-258.81	0.01095	0.004265	0.008601	0.18241	0.08982	0.18288
$[-261]$	—	—	0.002718	—	—	—
$[-262]$	—	0.008257	0.002526	—	—	—

Dewar found 0.03290, whereas the authors find 0.008103 at -252.98 (for Au). *Mercury*.—This was doubly distilled and placed in a glass spiral, protected by a pentane bath immersed in the cryostat.

Temperature....	0°	-188.00	-205.01	-215.84	-252.98	-258.81
Resistance.....	97.126	7.2650	5.8900	4.5057	1.2618	0.7584

Silver.—This contained 0.18 per cent. impurity; resistance at 0° 21.519 ohms.

Temperature 0°	-108.81	-183.57	-195.17	-204.67	-252.92	-259.22
Resistance ...	1	0.58087	0.24679	0.19708	0.15528	0.008913

Bismuth.—A spiral resistance 17.8188 ohms at 0° .

Temperature	0°	-108.71	-182.78	-204.68	-258.01	-258.86
Resistance	1	0.68649	0.41435	0.86064	0.22329	0.19574

Lead.—Probably only 0.015 per cent. impurity; strip, protected by paraffin against chemical action; resistance at 0° 8.18114 ohms.

Temperature.	Resistance.	Temperature.	Resistance.
$+16.88$	1.0652	-204.52	0.21742
0°	1	-216.81	0.17129
-108.68	0.59548	-252.78	0.08082
-188.65	0.29489	-255.07	0.02814
-195.15	0.25257	-258.70	0.01811

The importance of these results is pointed out, since lead does not show the Thomson-effect. The corrections required and the agreement of the above-given results with the authors' new formula are discussed, and Nicolai's results (with less pure metals) referred to [Abstracts Nos. 1567, 1568 (1907)].

851. Absolute Measurement of Capacity and Self-induction. J. K. A. Wertheim-Salomonsen. (Phys. Zeitschr. 9. pp. 222-225, April 1, 1908.)—There are two special measurements. In the first the ratio L/C is obtained as the product of two resistances, Maxwell's method or one derived from it being used. In the second measurement the same capacity and self-induction are placed in series in a make-and-break circuit, and the frequency of the oscillations thus set up is measured photographically. An Einthoven string galvanometer was included in the circuit and its vibrations recorded. Any good oscillograph might be similarly used. F. E. S.

852. Resistance Comparator. W. C. Fisher. (Electrician, 60. pp. 784-785, March 8, and pp. 824-827, March 18, 1908.)—The author discusses the possible errors of the potentiometer method of comparing resistances, and especially that due to the possible alteration in the potential of the circuits in the interval elapsing between the balancing of the standard and that of the resistance which is to be compared with it. In the apparatus described, which is adaptable to other purposes than the comparison of resistances, this "comparison lag" is practically eliminated by the reduction of the number of operating movements and the bringing of all parts into a convenient compass. The essential feature is the employment of two sliders and a movable slide-wire. With a fixed wire any alteration of potential in either circuit entails either rheostat adjustment or a readjustment of both sliders, but with this movable slide-wire any alteration of potential can be rectified by altering the position of the slide-wire itself, so leaving the sliders the same relative distance apart. The possible sources of error are discussed, and are shown to be very small. Reference is also made to a "ribbon plotting" system of recording resistance values initiated by the author. F. E. S.

V.
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ALTERNATING CURRENTS AND MAGNETISM

853. International Magnetic Standard. L. A. Bauer. (Terrestrial Magnetism, 12. pp. 161-164, Dec., 1907.)—Intercomparisons of magnetic instruments made by various investigators during the past twenty years have served to call attention to the discrepancies existing between the determination of the magnetic elements by various observatory and magnetic survey instruments, discrepancies far exceeding the errors of observation. Thus comparisons show that for horizontal intensity the Potsdam standard is invariably lower than Kew, Parc-St. Maur, Rome, &c., by amounts varying from 5γ to 45γ. Kew appears to be very near the value of an international standard. For survey purposes the author has assumed that the Cheltenham (U.S.A.) standard has to be diminished by 0.001H for using as the provisional international standard for the Carnegie Institution work. The differences for declination between any two carefully corrected instruments are generally below 2'. In intercomparing instruments experience indicates that the declination comparisons should always be included. As good modern earth inductors will give values of the inclination agreeing within a fraction of a minute they are to be preferred to dip circles, in which the corrections are known to be functions of the dip. C. P. B.

854. Registration of Earth Currents at Batavia. W. van Bemmelen. Konink. Akad. Wetensch. Amsterdam, Proc. 10. pp. 512-533, Feb. 20, 1906.)

—These observations are undertaken for the investigation of the connection between earth currents and magnetic forces. During the period March–Nov., 1905, the author registered the earth-current variations between Cheribon and Batavia. Tables are given of the observations with the corresponding values of the magnetic variations, and a direct similarity is apparent in the character of the double annual period. In the variations of short duration it is found that the vibration in the earth current precedes that of the magnetic component with a certain difference of phase, and the ratio of amplitude of earth current and magnetic component decreases when the deviation of the vibration increases. C. P. B.

ELECTRO-PHYSIOLOGY AND ELECTRO-THERAPEUTICS.

855. *New Apparatus for Measuring the Intensity and Quantity of Röntgen Rays.* C. Luraschi. (Archives d'Él. Médicale, 16, pp. 14–26, Jan. 10, 1908.) —The method is based on the fact that the electrical resistance of selenium falls while it is submitted to the action of Röntgen rays, and returns to normal when the rays cease [see Perreau, Abstract No. 628 (1900)]. Experiments show that there exists a relation between the quantity of Röntgen rays emitted by the tube and the deviation of the milli-ammeter needle. Variation of 1 amp. in the intensity of the primary current corresponds to from 0.2 up to 1 milliamp. By causing the rays to act on the selenium through the medium of a fluorescent screen the deviations of the needle are increased. The apparatus, which the author speaks of as only tentative, consists therefore of a selenium cell provided with a fluorescent screen, a milli-ammeter graduated to hundredths of a milliamp., and a chronometer. As a scientific unit he suggests the quantity of Röntgen rays corresponding to one division on the scale of the milliammeter, a unit which may be defined as the quantity which will liberate a definite number of mgm. of iodine in a 2 per cent. solution of iodoform in chloroform (Freund's method), or which will precipitate a given number of mgm. of calomel in a solution of oxalate of ammonium and sublimate (Schwartz's method). Some objections to the method are pointed out, but these, the author thinks, may be obviated by further perfection of the apparatus. H. W. P. Y.

856. *New Stereoscopic Method of Localising Foreign Bodies by Radiography.* J. Gillet. (Archives d'Él. Médicale, 16, pp. 102–110, Feb. 10, 1908.) —The author's apparatus is a stereoscope consisting of two eyepieces mounted on two parallel rods of variable length (80 to 60 cm.). At the other end of the rods, at right angles to them, is a clamp for holding the radiograph. In taking the radiograph it is necessary that the two positions of the tube should be such that the distance between the two normal rays be equal to the distance between the two eyepieces, and the height of the antikathode above the plate be equal to the length of the rods. In using the stereoscope the radiograph is placed in such a position that the observer sees one image with the right eye and the other with the left. Then by an effort of accommodation he allows the two images to blend. The point between the radiograph and the observer at which the blended image appears is registered by means of a glass plate which slides up and down the rods on a graduated scale. The glass plate itself carries a vertical and a horizontal scale. By means of data thus obtained the position of the foreign body can be easily and accurately determined. H. W. P. Y.

857. The Mode of Action of High-frequency Currents. J. K. A. Wertheim-Salomonsen. (Archives d'Él. Médicale, 16. pp. 43-47, Jan. 25, 1908.)—Observations of the body temperature of a man submitted to the action of a high-frequency current of 850 milliamps. for 10 min. show that there is a rise of 0.218°C . The author attributes this to a physical cause, namely, to the energy communicated by the current. He calculates that the energy communicated to the body of a man weighing 67 kg. by such a current in 10 min. would be sufficient to produce a rise of temperature equal to 0.28° . But during the treatment the dilatation of the cutaneous blood-vessels produced by the current induces an increased loss of heat from the surface of the body, so that the figures obtained by observation and by calculation may be said to agree. H. W. P. Y.

REFERENCES.

858. Electromagnetic Theory. G. Fubini. (Accad. Lincei, Atti, 17. pp. 195-199, Feb. 16, 1908.)—Considers the effect of a dielectric layer in an electromagnetic field. The results contradict the conclusions of Karpen, and are more in agreement with those of Pender and Crémieu. E. E. F.

859. Unipolarity of Atmospheric Electric Dispersion. K. Kurz. (Phys. Zeitschr. 9. pp. 218-221, April 1, 1908. Physikal. Inst. d. techn. Hochschule, München, Feb. 20, 1908.)—More recent work by the author [Abstract No. 437 (1908)] seems to confirm his previous work [Abstract No. 2059 (1906)], and in the present paper he replies to Kohlrausch's criticism [Abstract No. 1886 (1907)], pointing out some inaccuracies in Kohlrausch's work. A. W.

860. Wehnelt Kathode in High Vacuum. J. E. Lilienfeld. (Phys. Zeitschr. 9. p. 193, March 15, 1908.)—The author has shown that as the pressure decreases the potential gradient in the positive column greatly increases; also that there is a tendency for the volume density of the negative electricity in the tube to become as great as possible. Both these effects hinder the passage of the discharge if carried by electrons. This is probably the explanation of Soddy's results [see Abstracts Nos. 108 and 443 (1908)]. R. S. W.

861. Electrical Conductivity and Temperature Coefficients of Alloys. E. Rudolf. (Phys. Zeitschr. 9. pp. 198-201, March 15, 1908. Inst. f. physikal. Chemie d. Univ., Göttingen.)—A very good account of the various laws that have been given for these quantities since Matthiessen, showing the relation between several of the different formulæ proposed. R. S. W.

862. Measurement of Electrolytic Resistance. G. Athanasiadis. (Phys. Zeitschr. 9. pp. 225-226, April 1, 1908.)—A description of a method for comparing the resistance of an electrolyte with a non-inductive resistance, using a differential telephone. F. E. S.

863. On the Canal-ray Group. E. Goldstein. (Deutsch. Phys. Gesell., Verh. 4. pp. 228-244, 1902. Phil. Mag. 15. pp. 373-385, March, 1908. Translation.)—[See Abstract No. 2252 (1902).]

864. Resistance of Solenoid for High-frequency Currents. A. Battelli. (Accad. Lincei, Atti, 17. pp. 61-64, Jan. 19, 1908.)—The paper is a reply to one by A. Sommerfeld [Abstract No. 133 (1908)], in which it is stated that the author had improperly applied Rayleigh's formula for the resistance of a straight wire [see Abstract No. 1899 (1906)]. It is now pointed out that the treatment was not intended to be rigid, and was justifiable when the object was merely to determine the approximate distribution of current in the side of the wire facing the axis of the solenoid. S. G. S.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

885. *Action of some Electrolytes on Colloidal Silver Solutions and the Process of Coagulation.* H. W. Woudstra. (Zeitschr. Phys. Chem. 61. pp. 607-632, Jan. 81, 1908. Inaug.-Dissertation, Leiden, 1905.)—The author has investigated the precipitation of colloidal silver solutions by various electrolytes, the limiting dilution being obtained in each case, beyond which no precipitation occurred. The coagulating power increases with increase in the valency of the kation. Further, the sensitiveness of the silver sol increases with time and with increase in concentration. The author regards colloidal solutions as being of two kinds: one where the colloid particles cling together to form a sort of sponge, and the other where the particles are separate. In the former case diffusion of the ions into the colloid can take place, and the surface tension of the liquid will alter, owing to potential differences. If the surface tension increases the spongy structure will contract and coagulate; if it diminishes the viscosity of the sol will decrease. In the case of colloid solutions of the second type, the author regards coagulation by electrolytes as due to the ions acting as nuclei round which the colloid particles agglomerate. A. F.

886. *Viscosity and Conductivity.* K. Arndt. (Zeitschr. Elektrochem. 18. pp. 809-812, Dec. 20, 1907. Elektrochem. Laborat. d. techn. Hochschule, Charlottenburg, Dec. 2, 1907.)—It has been clearly established that in a large range of cases [cf. Walden, Abstract No. 1827 (1906)] the product of viscosity and electrical conductivity of an electrolyte remains constant under wide variations of conditions. The author has examined the case of fused mixtures of sodium metaphosphate, NaPO_3 , and boric anhydride, B_2O_3 . Sodium phosphate itself shows a remarkable decrease of viscosity, in the ratio of 8:1 approximately, in the narrow range from 650° to 750° C., but this is not accompanied by any abnormal increase of conductivity. In the case of a mixture of 50 per cent. NaPO_3 , 50 per cent. B_2O_3 , there is a similar rapid decrease of viscosity between 800° and 850° , but the same interval is characterised by a marked increase of conductivity, although the change of conductivity is smaller than the change in the viscosity. A full confirmation of the above relationship was, however, obtained in the isothermal conductivity of various mixtures of NaPO_3 and B_2O_3 at 900° C.; the molecular conductivity in this case varied from 49.5 to 0.67, but when multiplied by the viscosity remained constant at 74.8, 78.8, 78.3, 78.7. T. M. L.

887. *Measurement of Electrode Potentials.* W. Kistiakowsky. (Zeitschr. Elektrochem. 14. pp. 113-121, March 6, 1908. Physikal.-chem. Laborat. des Polytechn. Inst., St. Petersburg, Dec. 17-30, 1907.)—In measuring the e.m.f. of galvanic cells which contain metallic electrodes, it is necessary to rotate the latter in order to eliminate the action of local currents, which may be formed at the surface of stationary electrodes. Correct results can only be obtained by comparison of the e.m.f.'s obtained with stationary and rotating electrodes. It is absolutely necessary for the part of a metallic electrode which is at the surface of the electrolyte to be protected from the action of the air, since in most cases an electrode gives a different e.m.f. at the point where the electrolyte is in contact with the air from what it does in

the interior of the electrolyte. In many cases it is necessary to eliminate the action of varying concentrations of dissolved oxygen (from the air) in the electrolyte, by building the cell in such a way that air is prevented from diffusing into the electrolyte during rotation of the electrode. The influence of dissolved oxygen is the greater the nobler the metal of which the electrode is made. The surface of the electrode used must be polished, and also examined microscopically in both a wet and dry condition; in some cases, e.g., Mg, the existence of local currents can thus be observed on the wet electrode. In the exact measurement of the e.m.f. of galvanic cells, their circuit must never be closed through a resistance of less than 10^5 ohms. In building up such cells in order to measure electrode potentials, care must be taken to prevent chemical action taking place at the surface of contact of the two electrolytes, e.g., when normal mercury electrodes are used they must be so chosen that the electrolyte surrounding the mercury, and that surrounding the metal to be investigated both have the same anion or kathion. The following e.m.f.'s have been determined:—

Zn/equiv. n. ZnSO_4 /sat. $\text{ZnSO}_4(\text{Hg}_2\text{SO}_4)/\text{Hg} = 1.46102 - 0.000682(t - 18)$ volts between 15 and 25°.

Zn/equiv. n. $\text{ZnSO}_4/0.1$ n. $\text{KCl}(\text{Hg}_2\text{Cl}_2)/\text{Hg} = 1.18564$ volts.

The temperature-coefficient of this cell is zero between 15 and 25°. The accuracy of measurement is 1×10^{-5} volt per 1° C. T. S. P.

888. *The Silver Voltameter*, Part I. F. E. Smith and T. Mather. Part II. F. E. Smith and T. M. Lowry. (Roy. Soc. Phil. Trans. Ser. A. 207. pp. 545-599, Feb. 26, 1908. Proc., Ser. A. 80. pp. 77-79, Dec. 9, 1907. From the National Physical Laboratory. Abstract.)—The first two-mentioned authors have made a careful investigation of the electrochemical equivalent of silver, using voltameters of very different types and very differently concentrated solutions. As a result they find that if the silver nitrate is quite pure consistent results (within 1 or 2 parts in 100,000) are obtained with the different voltameters, and under varying conditions of pressure and temperature as well as current density. The mean value of their determinations is 1.11827 mgm. of silver deposited by 1 coulomb. It is pointed out that with very small kathodes, a small quantity of electrolyte, a small anode, a relatively large mass of filter paper, and current densities either very high or very low, different amounts of silver may be deposited. In the second paper the question of impurities and their influence on the deposit is discussed. High values for the deposit are found when the solution contains oxide, carbonate, chloride, nitrite, or hyponitrite, but low values when acids are present. The high values are probably due to the impurities being soluble in the fairly concentrated silver nitrate solutions but insoluble in water. As the solution gets less concentrated at the kathode these impurities get deposited on the kathode. As it is found that slightly abnormal values are obtained when the same solution is repeatedly electrolysed, it is advisable to use fresh solutions for each experiment.

889. *Electrochemical Behaviour of Silver and its Oxides*. I. R. Luther and F. Pokorný. (Zeitschr. Anorg. Chem. 57. 8. pp. 290-310, March 4, 1908. Physikal.-chem. Inst. d. Univ., Leipzig.)—When silver is oxidised anodically in alkaline solution the oxide Ag_2O is first formed, the reaction being quantitative and reversible. Further oxidation, which is also quantitative and reversible, then takes place to AgO ; a higher oxidation product cannot be

formed in alkaline solution. The anodic oxidation of silver, or of silver oxide, in alkaline solution, appears to be the best method for obtaining the "normal" silver oxide, Ag_2O . Wöhler's silver peroxide is practically identical with Mulder's peroxide salts of silver; in all cases the silver peroxide Ag_2O_2 is the fundamental substance. In alkaline solutions Ag_2O_2 is reduced at the cathode to Ag_2O , which is further reduced to Ag_2O , finally giving Ag -metal. In acid solution Ag_2O_2 is reduced, cathodically to Ag -ions, and is moreover produced from Ag -ions at the anode. Ag_2O and Ag_2O_2 are probably oxides of di- and tri-valent silver respectively. The following e.m.f.'s (referred to H_2 in the same solution) have been measured at 25° : $\text{Ag}, \text{Ag}_2\text{O} - \text{H}_2 = +1.172$ volts; $\text{Ag}_2\text{O}, \text{Ag}_2\text{O} - \text{H}_2 = +1.40$ volts; $\text{Ag}_2\text{O}_2, \text{Ag}_2\text{O} - \text{H}_2 = +1.67$ volts. These values are independent of the strength of the alkali. $\text{Pt}, \text{Ag}_2\text{O}_2, \text{Ag}_2\text{SO}_4$ sat., $0.5 \frac{\text{H}_2\text{SO}_4}{2}, \text{H}_2 = +1.74$ volts (calculated $= +1.70$ volts). Lewis's value for the oxyhydrogen cell must be raised from 1.217 to 1.221 volts—

+ $\text{Hg}, \text{HgO}, \text{n. NaOH}, \text{H}_2 - = 0.962$ volt;

+ $\text{Hg}, \text{HgSO}_4, 0.5 \frac{\text{H}_2\text{SO}_4}{2}, \text{H}_2 - = 0.744$ volt.

+ $\text{Hg}, \text{HgSO}_4, 0.5 \frac{\text{H}_2\text{SO}_4}{2}, \frac{1}{2} \text{ sat. KCl}, \text{n. KCl}, \text{HgCl}, \text{Hg} - = 0.886$ volt.

+ $\text{Hg}, \text{HgSO}_4, 0.5 \frac{\text{H}_2\text{SO}_4}{2}, \text{sat. KCl}, \text{n. KCl}, \text{HgCl}, \text{Hg} - = 0.894$ volt.

+ $\text{Ag}, 0.1 \text{AgNO}_3, \text{n. KNO}_3, 0.5 \frac{\text{H}_2\text{SO}_4}{2}, \text{Ag}_2\text{SO}_4 \text{ sat.}, \text{Ag} - = 0.046$ volt at 18° .

T. S. P.

870. Electrolysis of Lithium Chloride in Pyridine and in Acetone. H. E. Patten and W. R. Mott. (Journ. Phys. Chem. 12, pp. 49-74, Feb., 1908.)—Lithium may be deposited from an anhydrous saturated solution of its chloride in pyridine or acetone upon a smooth Pt cathode at a current density of 0.001 amp./cm.^2 , the temperature being 25°C . The cathode polarisation due to deposited Li is $+2.60$ volts in either solvent, although the heat of solution in pyridine is equivalent to 0.618 volt and in acetone to 0.254 volt, as compared with 0.871 volt in water. The passage of the current through the pyridine solution soon ceases in the presence of a very small quantity of water, an insulating film being formed upon the cathode. The specific electrical conductivity of LiCl in pyridine at 25°C ., determined at strengths of from 0.052 to 1.85 per cent., rose from 0.171×10^{-4} to 0.958×10^{-4} . The addition of a small proportion of water considerably raises the conductivity of the pyridine solution, but that of the acetone solution shows a much smaller rise, and may even be very greatly lowered owing to the formation of two liquid phases, the water-rich phase having the higher percentage of LiCl . The current efficiency in depositing Li from pyridine solution is 28.3 per cent. at a current density of 0.1 amp./cm.^2 ; from acetone solution 38.5 per cent. at a current density of 0.001 amp./cm.^2 ; and from amyl alcohol solution 44.8 per cent. at a current density of $0.0012 \text{ amp./cm.}^2$. W. H. Sr.

871. Electrolytic Separation of Nickel and Zinc. F. Foerster and W. Treadwell, Jr. (Zeitschr. Elektrochem. 14, p. 89, Feb. 21, 1908. From the Laborat. f. Elektrochem. u. physikal. Chemie an der techn. Hochschule, Dresden.)—The separation of nickel and zinc [see Abstract No. 1975 (1907)] from an ammoniacal solution containing sulphite (temp. 90°) can be carried out successfully, but the deposit of Ni always contains sulphur, and is con-

sequently about 2 per cent. too heavy. In order to estimate the Ni, the deposit must be dissolved and the electrolysis carried out at ordinary temperatures, sulphate being excluded. T. S. P.

872. Use of a Filtering Crucible in Electrolytic Analysis. F. A. Gooch and F. B. Beyer. (Amer. Journ. Sci. 25. pp. 249-255, March, 1908. Contribution from the Kent Chem. Lab. of Yale Univ.)—The rapidity with which a metal or oxide may be deposited upon the electrode and thereafter handled successfully in the ordinary processes of electro-analysis, depends upon keeping to conditions under which deposits are compact and adherent. The authors describe an apparatus by means of which loose deposits may be successfully dealt with; accurate determinations may be made in a comparatively short time without the use of motors or special stirring apparatus, and without large and expensive apparatus of Pt. The kathode consists of a Gooch crucible, charged in the ordinary way with asbestos felt, but containing also some clippings of Pt-foil which act as the kathode. The crucible is prolonged by a glass cylinder, which is kept in position by a rubber band, and may be removed when the weighings are made. After the electrolysis, the cap at the bottom of the crucible is removed, and the contents washed in the ordinary way. When a deposit is loosely adherent it may be compacted upon the filtering felt by filtering the electrolyte during the process of electrolysis, the filtrate being returned continuously to the crucible until the deposition is complete; the deposit is then finally washed with water. The method has been tested by depositing Cu from a solution of the sulphate acidified with sulphuric acid. The current used varied from 2-4 amps. at 5-10 volts, the time necessary for the deposition of 0.1280 gm. Cu being 25-45 min. The errors were very small, and comparable with those occurring in the ordinary methods of electrolytic analysis. T. S. P.

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873. van der Waals' ψ -surface. XII. and XIII. *On the Gas Phase Sinking and Rising in the Liquid Phase for Binary Mixtures.* XII. H. Kamerlingh Onnes and W. H. Keesom. (Konink. Akad. Wetensch. Amsterdam, Proc. 9. pp. 501-511, Jan. 24, 1907. Communications Nos. 96b and c from the Phys. Lab., Leiden.) XIII. W. H. Keesom. (Ibid. pp. 508-511, Jan. 24, and pp. 660-664, March 28, 1907.)—[Erratum, p. 598.]

874. Plaitpoint and Spinodal Lines. J. J. van Laar. (Konink. Akad. Wetensch. Amsterdam, Proc. 10. pp. 34-46, June 21, and pp. 238-239, Oct. 31, 1907.)—A discussion of the course of the plaitpoint line and of the spinodal lines is here given, that case being specially considered in which the mutual attraction of the molecules of one of the two components of a binary mixture of normal substances is slight. It is also pointed out that all the formulæ and results obtained by Keesom, either separately or in conjunction with Kamerlingh Onnes [see preceding Abstract], were previously given by the author in papers which are summarised in Abstract No. 758 (1907). R. E. B.

875. van der Waals' ψ -surface. XV. H. Kamerlingh Onnes and W. H. Keesom. (Konink. Akad. Wetensch. Amsterdam, Proc. 9. pp. 786-798, April 25, and 10. pp. 281-287, Oct. 31, 1907. Supplement No. 15 to the Communications from the Phys. Laborat., Leiden.)—In continuation of a former paper [see Abstract No. 918 (1907)] and in answer to a criticism of the same by van Laar [see preceding Abstract]. R. E. B.